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UNIVERSITY OF MALAYA IN SINGAPORE AND
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POPULATION DISTRIBUTION IN MAURITIUS

An inquiry into the determinants of distribution in a tropical sugar island

By H.C. BROOKFIELD

INTRODUCTION

A RAPIDLY increasing population of over 550,000, directly or indirectly dependent for sustenance almost entirely on the production of cane sugar, is crowded onto the island colony of Mauritius (Fig. 1). The colony is now advancing towards a quasi-independence, and is of interest as an example of acute population pressure, as the home of the only Indian emigrant community to form a large local majority, and as the largest single cane sugar producer in British overseas territories. Of the island's 720 square miles, some 39 per cent is under sugar, and 6 per cent is devoted to other crops. Twenty per cent is used for grazing of a sort, but the uncultivated area is little peopled and largely unused.[1]

Mauritius has no indigenous population in the accepted sense; the island was uninhabited when discovered by the Portuguese, and the whole population, their crops, their diseases and the vectors of disease are imports from without. Population distribution has been conditioned by a clearly recognisable series of environmental factors: from dependence on cane sugar has followed a limitation of rural settlement to areas suited to this crop; the choice by the *Compagnie des Indes* of the north-western harbour as the site for their port in 1735 determined the site of the capital city and subsequently of the system of communications which guided later urban settlement; the introduction of malaria, and its spread by means of *A. gambiae* and *A. funestus* placed a premium value on the high ground. It is the object of this paper to discover the causes of the evolving pattern of distribution. After a preliminary statement of the physical and demographic setting, geographical variations in population change are examined under the headings of the several factors that have, at different times, exerted a dominant influence. The discussion is then concluded by an examination of the mechanism of population distribution, through demographic differentials, internal migration and circulation.[2]

The Environment

Mauritius is wholly volcanic in origin, formed by three periods of eruption ranging from early Tertiary to mid-Pleistocene. The earliest series built up a great

1. The dependencies of Mauritius are excluded from this study. The principal of these, Rodrigues, has an acute population problem of its own, with over 15,000 people dependent on the subsistence resources of a mountainous island of forty-two square miles. The remaining dependencies, a series of coral and sand patches thinly scattered through the western Indian Ocean, are occupied only for coconut plantations.
2. The principal source material for this paper was found in the reports of the successive censuses of Mauritius from 1846 to the present day, together with some earlier manuscript material. The censuses of 1881 (the best in the nineteenth century), 1911, 1921, 1944 and 1952 were subjected to very full analysis, only a part of which appears in this paper. Some unpublished data from the 1944 and 1952 censuses were also made available.

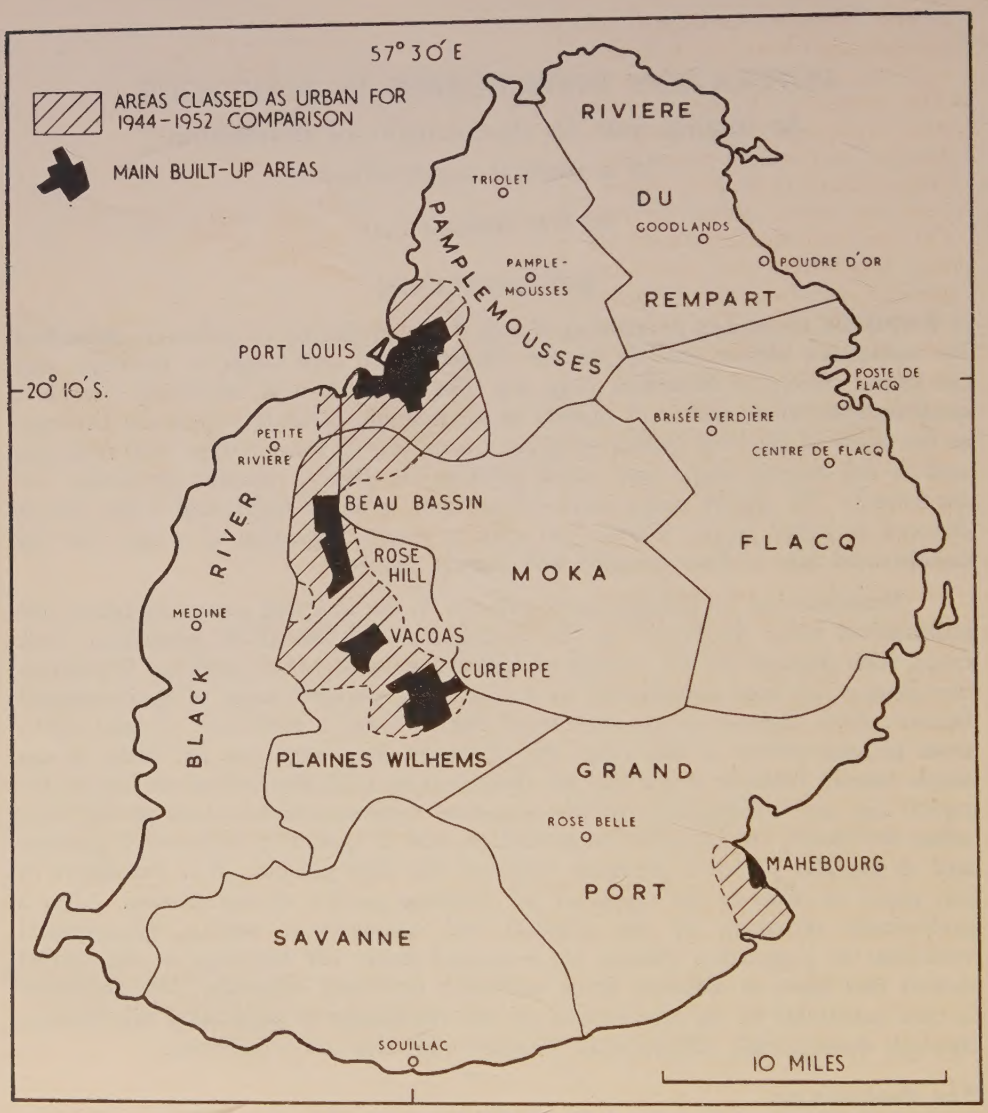

Fig. 1. Mauritius, districts and localities.

cone, like that which still towers over 10,000 feet on Réunion. The Mauritian cone underwent caldera subsidence, and its remains were later invaded first by a restricted series of flows on the south-western flank, then by a series of shield volcanoes, poured out from some twenty vents aligned down the long axis of the island (Fig. 2).[1]

1. E.S.W. Simpson, 'The Geology and Mineral Resources of Mauritius', *Colonial Geology and Mineral Resources,* Vol. 1, No. 3, 1950, pp. 217-35; F. Walker and L.O. Nicolaysen, 'The Petrology of Mauritius', *Colonial Geology and Mineral Resources,* Vol. 4, No. 1, 1954, pp. 3-43; S.J. Shand, 'The lavas of Mauritius', *Quarterly Journal of the Geological Society of London,* Vol. 89, 1933, pp. 1-13.

The present landscape is compounded both of erosional and constructional elements. The remains of the caldera now constitute a part-ring of bizarre tooth-like mountains, fully mature in a cycle dominated by rapid slope retreat. On the intermediate flows in the south-west an erosional escarpment has eaten some distance inland. The remainder of the landscape is the barely modified surface of the recent lavas. The craters are still present, and radiating belts of *aa* flow are still marked by belts of particularly bouldery soil; the only real modification is in the gorges that have been cut by certain streams. There are also local patches of raised beach round the coast and most of the island is girt by a coral reef, separated from the shore by a shallow lagoon.

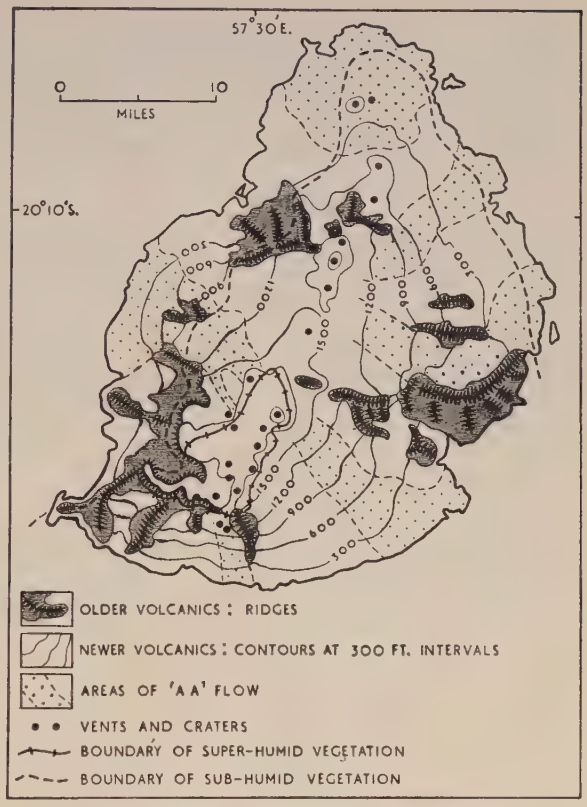

Fig. 2. Selected elements of the physique.

For over half the year the island lies under the south-east trades; during the summer months these fall back to give place to the intertropical convergence, and tropical cyclones are liable to occur. On occasions the cyclones wreak great damage, but their more general effect is to supplement convectional rainfall to make summer the wettest season.

Mauritius is a characteristic tradewind island in that the effect of relief on rainfall is very marked. On the windward slope of the island there is an almost perfectly regular increase of 8 inches in average annual rainfall for each 100 feet of height, the annual mean rising from about 50 inches on the coast to nearly 200 inches on the high ground above 1,800 feet. The orographic effect is, naturally, most marked in the winter three months. The central ridge of the island is consequently very humid and has a high proportion of cloud cover. On the leeward slope humid conditions extend down to about 1,300 feet, but the leeward coast, and especially the lowlands below the Port Louis mountains and the south-western plateau are almost rainless in winter. The annual mean in Port Louis and in southern Black River is only between 32 and 52 inches.[1]

Thus, despite the small size of Mauritius there is marked variety of natural environment. A super-humid area on the high country of the south-west, characterised by heath and climax rain forest and moss forest in the highest parts, is

1. M.V.M. Herchenroder, *La pluie a l'île Maurice* (Port Louis, 1935); P.R. Crowe, 'The Trade Wind Circulation of the World', *Transactions and Papers, Institute of British Geographers,* No. 15, 1949, pp. 37-56; 'The Seasonal Variation of the Trades', ibid, No. 16, 1950, pp. 23-47; 'Wind and Weather in the Equatorial Zone', ibid, No. 17, 1951, pp. 23-76.

almost wholly too wet and cool for occupation of any kind practised in the island. Along the leeward coast, and extending a short distance along the windward coastal fringe, is a sub-humid area, marked out by aloes, acacias and winter drying of the grass. Irrigation is necessary for sugar cultivation in most of this belt. In the south-west, where the fall from the plateau to the coast is precipitous, super-humid and sub-humid conditions are almost juxtaposed.[1]

The Demographic Background

Despite discovery by the Portuguese in 1505, abortive settlement by the Dutch between 1638 and 1710, and attempts at settlement by the French from Réunion[2] after 1715, it was not until 1735 that a substantial colony was established on the island. During the French period, when the island served as port of call and naval base, population grew slowly to reach about 75,000, including some 8,000 whites and over 60,000 slaves at the time of the British conquest in 1810.[3] Until 1838 the population continued to fluctuate but never reached 100,000, then it underwent a rapid increase that carried it to 365,000 by 1865. Subsequent decline was followed by a long period of stagnation and slow growth, leading into a sharp upward movement after 1944.

Natural increase has contributed little until the last eleven years. Kuczynski's series of vital rates[4] shows an excess of death rates over birth rates in all but ten of the forty years between 1831 and 1870, and in 1867, when malaria ravaged the island, more than one in ten died. Growth therefore depended mainly on immigration. Between 1735 and 1810, at least 80,000 to 100,000 slaves were imported, mainly from Moçambique and Madagascar, with smaller contributions from Arab East Africa, Asia and West Africa. Probably a further 20,000 were imported, mostly by smuggling, between 1810 and 1829.[5] After about 1823 the trade was checked, and the emancipation of the slaves in 1834 precipitated a crisis in the expanding sugar industry. In the search for new sources of labour, Indian convicts were imported after 1816, and recruitment of indentured labour from India began in the eighteen-thirties. After some checks, the flow became substantial in 1843, when nearly 35,000 entered the colony. Indian immigration at once had an impact on population growth: by the eighteen-sixties Indian males accounted for over 40 per cent of the whole population. Over the whole period of recruitment from 1834 to 1925, there was a recorded entry of 347,000 males and 106,000 females under indentures, leading to a net gain of 215,000 males and 76,000 females.

Massive immigration ceased soon after the malaria epidemic of 1867, though in the mid-seventies and in odd years later, entry exceeded 5,000 a year. From 1880 on there was generally a net loss of indentured migrants. Free migration, poorly recorded since 1875, shows a net gain of only some 13,000 to the present day. The result of this shrinkage in the immigrant flow, coupled with the effects of the heavy male preponderance in the population, was to lead to a decline in

1. R.E. Vaughan and P.O. Wiéhé, 'Studies on the Vegetation of Mauritius, 1. A Preliminary Survey of the Plant Communities', *Journal of Ecology*, Vol. 25, 1937, pp. 289-338.
2. Before 1815 Mauritius was known as the Ile de France, and Réunion as Bourbon.
3. R. R. Kuczynski, *Demographic Survey of the British Colonial Empire, Vol. II* (London), pp. 707-885. Kuczynski has made an exhaustive survey of the population history of Mauritius particularly for the period before 1870, and this account of the early period is based on his work. Kuczynski made no study at all of internal distribution.
4. Ibid, p. 868.
5. *Report of the Commissioners of Enquiry upon the Slave Trade at Mauritius* (1829). Parliamentary Papers, 1828-33, p. 11.

numbers. The decline would have been greater had not the malaria epidemic been followed by a period of over twenty years in which births consistently exceeded deaths. There was then a new period of stagnation and fluctuation, but since the second world war, greater prosperity, a higher marriage rate, and above all the elimination of malaria led to an upsurge without precedent. From 1950 to 1953 the annual increment surpassed 3 per cent per annum. Since 1949 natural increase has added over 100,000 to the population.

One important result of the manner of population growth has been the creation of a plural society in the island. In the slave period there were three groups, white, free-coloured and slave, though miscegenation on the grand scale and emancipation soon blurred these divisions. Since Indian immigration became substantial, all the 'old' groups have been collectively described as the 'General Population' to distinguish them from the 'Indian' or 'Indo-Mauritian' population and later from the smaller but distinct Chinese group. These divisions too are becoming increasingly inadequate over wide fringe groups, through intermarriage and social absorption following religious conversion. However, for better or worse, they continue to be used for census purposes. For practical purposes the main communal groups are: the white Franco-Mauritians;[1] the *gens de couleur;* the *Creoles,* or darker skinned *noirs;* the Christian Indians; the Christian Chinese; the Chinese proper; the Hindu Indians with some endogamous caste groups; the *Bihari* or *Hindi* Muslims, and a number of very close Muslim trading groups; and the Gujerati. Some of these groups hold themselves aloof far more than others. The Hindu Indians are the largest group, forming just under half the whole population.

THE EVOLUTION OF THE DISTRIBUTION PATTERN

Figures 3 and 4 illustrate the growth of population in the island during the past century or more. There have been wide variations. In all districts a rapid initial rise, coinciding with the surge of Indian immigration, was followed by a check, and on the western or leeward side of the island the increase was

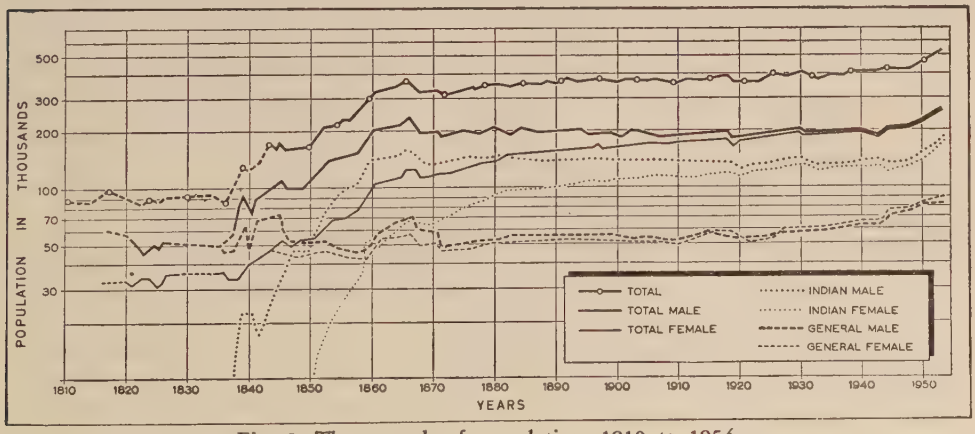

Fig. 3. The growth of population, 1810 to 1954.

1. This is more an endogamous group (or groups) than an ethnic division. They are in many cases distinguished from the *gens de couleur* by family name rather than appearance. Their number is estimated at 10,000 and they are often known as the *dix-mille,* but in fact they may be fewer.

replaced by an abrupt and prolonged decline. In all districts except Plaines Wilhems and, to a lesser extent, Rivière du Rempart, there was a long period of stagnation from the eighteen-sixties onwards. Moka did not share this stagnation at first, but after 1900 it lost population heavily. At the end of the series, since 1944, all curves turn upward, but even this recent phase is by no means uniform over the island.

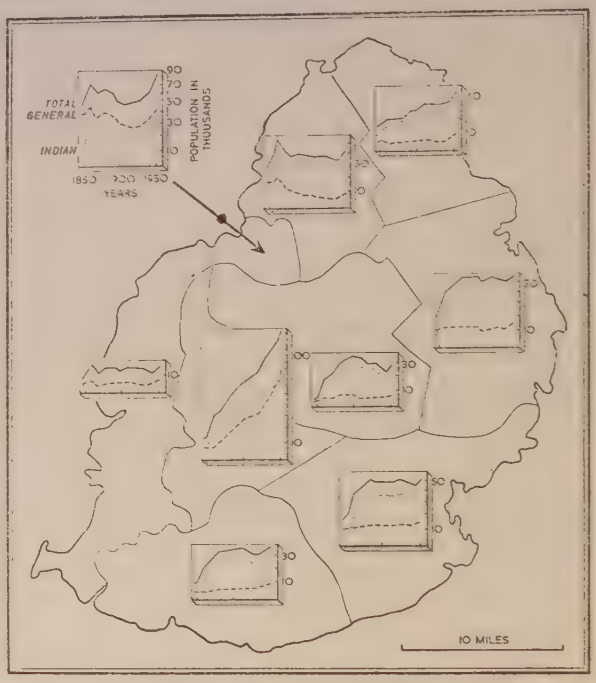

Fig. 4. Population change by districts, 1841 to 1952.

The Expansion of Sugar Cultivation

Sugar became the prime crop in Mauritius after 1810. Before that date rural settlement had spread mainly on the leeward side of the island, around Port Louis and in a discontinuous fringe around the coast (Fig. 5A). The interior was almost wholly unused. The success of sugar led to extensive clearing of the forests. Between 1810 and 1850 the area under sugar increased from 10,000 to over 100,000 acres and the indigenous forest shrank from 65 per cent to 15 per cent of the area of the island. The industry expanded at a rate limited only by the supply of labour and of new capital, and the limits of sugar cultivation at any time formed the limits of settlement. Cultivation spread all around the coastlands, even well down the sub-humid leeward coastland of Black River district (Fig. 5B). Only the steep ridges of the old volcanics, the super-humid country of the central ridge and the south-western plateau, and the *aa* belt of the Plaine de Roches in the north-east were not cultivated. In the centre the difficulty was as much lack of transportation as excessive moisture and low temperatures. Transport of sugar to the port was carried out by schooner from most of the island, and the centre remained undeveloped until the construction of two lines of ra converging on Port Louis, between 1862 and 1865.[1]

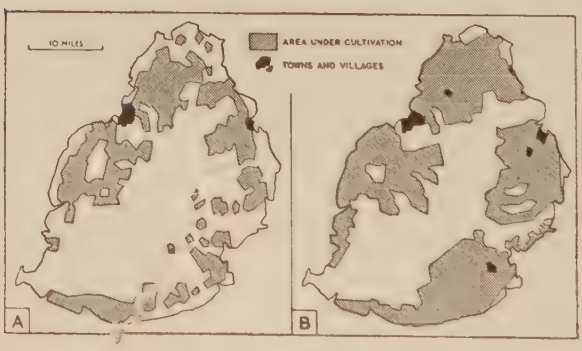

Fig. Extension of the cultivated area, 1807 to 1845.

[1] The system, which is on standard gauge, attained its apogee between 1880 and 1910. In recent years several branch lines have been pulled up and passenger services have been discontinued, mourned by connoisseurs of Victorian rolling stock, if by no one else.

The Impact of Malaria

Both the economy and the population reached a peak in the early eighteen-sixties. The colony had become the leading single producer of sugar in the whole British Empire and was an important way-station on the sea-route to Asia and Australia. With its development based on Indian labour the island was prosperous, but remained very unhealthy. Dysentery, typhoid and enteric fevers were endemic, and there were serious outbreaks of cholera in 1854, 1856, 1859, and 1861. There was, however, no malaria and this circumstance gave to Mauritius a somewhat undeserved reputation as a 'sanatorium'.

The continued absence of malaria is striking, in view of the constant flow of infected individuals, first from Africa and Madagascar and then from Asia, that entered the island for more than a century. Seemingly there was no carrier, but with increasingly frequent and faster steam-powered shipping it was inevitable that a carrier anopheline should eventually be introduced. This occurred in the eighteen-sixties at about the same time as in neighbouring Réunion, and the carrier was probably *A. gambiae*, brought from either Madagascar or Africa.[1]

In 1865 there was a sharp outbreak of malaria in central Black River and an epidemic wave, originating here, travelled right round the island in three years (Fig. 6), probably with the advance of the anopheline. Mortality among a susceptible population was enormous. In 1867 the recorded death rate attained 120 per 1000, and reached 247 per 1000 in Port Louis, where one twelfth of the population died in the month of April alone. However there were few cases above 600 feet, and the central uplands remained immune.

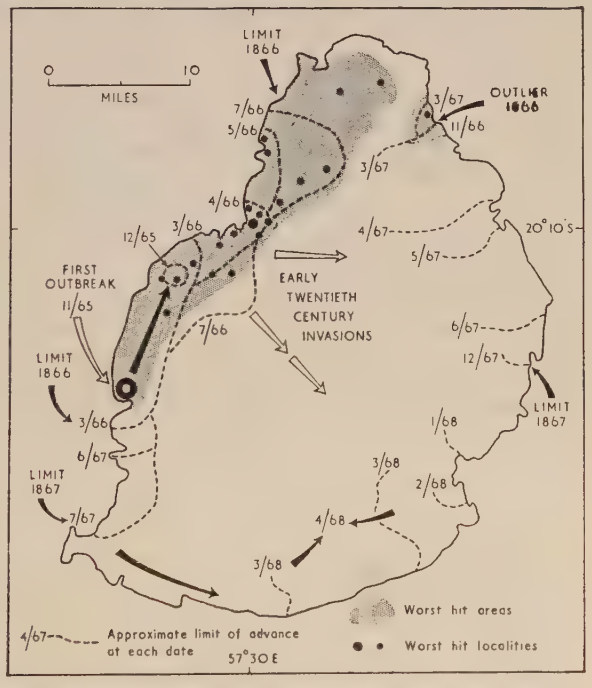

Fig. 6. The invasion of Mauritius by malaria, 1865 to 1868. (Based on the *Report of the Fever Inquiry Commission,* Port Louis, 1869).

It is convenient to follow the further history of malaria in Mauritius at this point, as its understanding is essential for an appreciation of the population changes that resulted. After the diastrous onset the disease abated somewhat for a few years, though it became established in the lowlands, and especially on the leeward coast and in the north. The Fever Inquiry Commission (1869), even though ignorant of

1. Rodrigues, with only slow and irregular shipping links to Mauritius, has remained free from malaria throughout. The interpretation of the introduction of the disease into Mauritius is, of course, not definite; it remains remotely possible that a very large body of infected individuals provided the means of introduction, and that *A. gambiae* was present before the eighteen-sixties.

anophelines, offered a sound explanation of this distribution by pointing to the better supplied streams on the windward side. In fact higher rainfall and the consequently more efficient flushing of streams and man-made breeding grounds alike was almost certainly the factor responsible for the contrast in endemicity, which remained evident throughout the malaria period.

After 1885 the incidence of malaria steadily increased, and in 1901, and again in 1906, the high ground of Moka-Plaines Wilhems was invaded. The true cause of the disease was now understood and prompt drainage and stream regulation was effective in coping with these new ingressions. It is possible that *A. funestus* was introduced as a second carrier about this time. Only *A. gambiae* was recognised in surveys as late as 1907, when Ross found this anopheline responsible for the outbreak at 1,400 feet in Plaines Wilhems. In 1922, however, no *A. gambiae* were found breeding above 1,200 feet but *A. funestus* was then first recognised, with winter breeding only below 500 feet. In 1927 *A. funestus* was found breeding in Curepipe at 1,700 feet. This behaviour, taking into account an observed preference by *A. funestus* for cooler water conditions than *A. gambiae,* would be consistent with a late introduction, but it is equally possible that the observations were at fault, and that *A. funestus* was present from the first.[1] However this may be, *A. funestus* speedily assumed the function of the main carrier, and when DDT spraying completely eliminated this anopheline after 1949, while equally completely failing to eliminate *A. gambiae,* transmission of malaria totally ceased, thus demonstrating that *A. funestus* had become the only vector.[2] Attempts were made to explain this unexpected discovery by arguing that *A. gambiae* had become zoophilic, but this was not established and the matter remains something of a mystery.[3]

The invasion of the island by malaria in 1867 had an immediate effect on the distribution of population, both by the devastating mortality that occurred on the leeward coast-lands and by the substantial internal migration that developed. This migration led initially to the windward coast, but ultimately to the central uplands where small urban colonies in Plaines Wilhems, developed as refuges during the cholera epidemics of the preceding decade, now proved to offer a sure retreat from malaria. The northern suburbs of Port Louis, which had been developing along the Pamplemousses road before 1867, were steadily drained of their population and a new group of suburban towns evolved along the central

1. B. De Meillon, 'Observations on *Anopheles funestus* and *Anopheles gambiae* in the Transvaal', *Publications of the South African Institute for Medical Research,* Vol. 6, No. 32, 1934, pp. 195-248, cited in M. Bates, *The Natural History of Mosquitoes* (1949) p. 119. It should of course be emphasised that African observations do not necessarily have validity in Mauritius, where *A. gambiae* at least has been domiciled for nearly a century.
2. It was formerly held that *A. funestus* was responsible for year-round malaria, while *A. gambiae* was responsible for the January-March seasonal peak.
3. This brief summary is derived from a wide variety of sources. A. Rankine, *Malaria in Mauritius and Suggestions for Future Policy in Regard to this Disease* (Port Louis, 1951), provides a good summary of the history and epidemology of malaria in the colony. On the initial invasion and the early period the best sources are: Government of Mauritius, *Report of the Fever Inquiry Commission* (1869): R. Ross, *Report on the Prevention of Malaria in Mauritius* (Port Louis, 1908); C. Meldrum, *Memorandum on the Death Rates of Mauritius* (Port Louis, 1888); C. Meldrum, *Relations of Weather to Mortality* (Port Louis, 1881); W. Chadwick, *Reports on Sanitation, Water Supply . . . in Mauritius* (Port Louis, 1891-2); Government of Mauritius, *Report of the Malaria Enquiry Committee, 1901-1902* (1903). On control measures, anophelines, the state of malaria in the island and its effects during the period before 1944: A. Balfour, *Report on Medical and Sanitary matters in Mauritius and certain aspects of Malaria in the Colony* (Port Louis, 1922); A. Rankine, *Report on Health Conditions in Mauritius* (Port Louis, 1944); F. A. Wilson, *Final Report: Nutritional Investigations in Mauritius, 1942-45* (Port Louis, 1946). On the elimination of malaria: M.A.C. Dowling, *Report on Progress of the Malaria Eradication Scheme* (Port Louis, 1949); *Annual Reports of the Medical and Health Department* (*Mauritius*), 1949 to 1955 inclusive.

railway. By 1880, Rose Hill (900 feet) and Curepipe (1,700 feet) were already well established. The move affected principally the General Population,[1] and gradually the Franco-Mauritians abandoned Port Louis altogether and concentrated principally in Curepipe. The population of Port Louis itself continued to decline for over half a century; epidemics of plague, smallpox and influenza took their toll in addition to endemic malaria, 'enterica', schistosomiasis and ankylostomiasis. Then in 1892 the worst cyclone in the island's history destroyed a large part of the city. There was also consistent decline in Pamplemousses and Black River, particularly in the latter district. Malaria robbed many coastal estates of a large part of their labour and reduced the effectiveness of the labour that remained. By 1880 many low-lying estates in the west, north and north-east had been abandoned,[2] but this loss of land—approximately 50,000 acres—was largely compensated by the clearing of some 40,000 acres of new land on the higher parts of the central uplands. The *Nouvelle Découverte* of Moka district, between 1,400 and 1,900 feet, was cleared at this time.

In the long term, malaria led to the establishment of two geographical differentials in health conditions: between the uplands and the lowlands, and between the windward and leeward sides. These will be examined more fully in a later section.

Rural Settlement: the Fragmentation of the Sugar Estates

The settlement pattern of Mauritius outside the towns was made up of only two elements before the last quarter of the nineteenth century. At nodal points, and at some coastal harbours, were old established villages many of which dated back into the eighteenth century, occupied largely by members of the 'General Population'. Some of the larger of these—Pamplemousses, Centre de Flacq, and Rose Belle—were the service centres for their surrounding districts. The coastal villages were sited on harbours served by schooners carrying goods to and from Port Louis. In a number of smaller villages strung out along the shores of the lagoon, fishing was the leading occupation. In these strand villages the population was and is overwhelmingly *Creole* of the most African variety.

The sugar estates constituted the second element. The industry was organized in a large number of small estates, few larger than 1000 acres, each with its own mill and almost invariably under the personal direction of a Franco-Mauritian owner.[3] The indentured Indian labourers, like the slaves before them were housed in 'estate camps' or 'coolie lines', which formed part of the estate buildings.

A number of causes contributed to a change in the structure of the sugar industry that transformed the settlement pattern of the colony. After the mid-seventies, large scale immigration virtually ceased, and as emigration and mortality reduced the number of the earlier migrants the adult Indian male population

1. On Fig. 4 the abandonment of Pamplemousses for Plaines Wilhems by members of the General Population may be clearly discerned.
2. R. Thompson, *Report on the Forests of Mauritius, their Present Condition and Future Management* (Port Louis, 1880), noted the low price of coastal land. *The Report of the Woods and Forests Committee on Mr. Thompson's report* (Port Louis, 1880) listed twenty-two estates 'and others' which had been abandoned. All were below 500 feet, and concentrated especially in the extreme north (see Fig. 7).
3. There had been some modification before the eighteen-eighties. The French law of inheritance operated to split some estates into smaller holdings, but this was more than offset by a general tendency towards consolidation. In 1846 there were some 4,000 planters, but there were fewer than half this number in 1870. The number of individual estates with factories probably reached a peak about 1860.

(which constituted by far the greatest part of the agricultural labour force) slowly declined in numbers from 106,500 in 1871 and 108,000 in 1881 to only 86,000 in 1911. Also many Indians whose indentures had expired and who did not return to India left the land. The Indian proportion of the population of Port Louis rose from 22 per cent in 1851 to 41 per cent in 1881. The sugar industry labour force thus fell in the same period from over 80,000 to little over 50,000. Labour shortage was gravely aggravated in the worst malarial districts.

A decline in the sugar price after 1880 led to increasing difficulties, while many low-lying estate factories were also hit by growing irregularity in their water supply, due to forest clearance on the watershed.[1] Finally a long period of cultivation without fertilisation had its inevitable result.

From about 1880, when 40.3 per cent of the whole population lived on the estates, numerous estates were sold in small lots. Frequently the buyers were free Indian migrants, with capital, who either became small planters themselves or (more usually) resold their land in yet smaller lots. A substantial proportion of the land reached the labouring class on the basis of share-cropping. Between 1880 and 1910 nearly half the sugar land passed into Indian hands. Much was inferior land, but some of first quality was also disposed of.

Fig. 7. Northern Mauritius (Mapou) in 1880 and 1949.

The nucleated settlement pattern thus gave way to semi-dispersal. Figures 7 and 8 illustrate the change. The labourers and share-croppers formed new villages strung out along the roads, or accreted to the old villages, and in some cases a wholly dispersed pattern resulted from fragmentation. Some *morcellements* became so small and close as to constitute new villages, and their inhabitants were forced to return to wage labour on a daily basis. Also several estates that had been abandoned were resettled by Indians in this way. Two of these in the north, Triolet and Goodlands estates, now form the core of the two largest villages in the island. The new villages and hamlets were built of houses entirely in the Indian style, and in time this style was also followed by the *Creoles*. Only the better-off continued to build the whimsical, insubstantial French Mauritian wood houses with their slanting windows, pinnacles and universal white and grey paintwork.

The estate population shrank rapidly, and by 1901 comprised only 26.8 per cent of the total. The process of fragmentation might have been carried much further, for it gave mutual satisfaction. It ensured a continuation of the supply of cane while leaving to the entrepreneur the more profitable milling side of the operation. At the same time, it gave new security and a stake in the land to thousands of former Indian labourers, and opened up an important means of advancement.

Fragmentation was terminated, however, by an accident. In 1902 an outbreak of *surra*[2] wiped out almost all the livestock in the island, decimating in particular

1. Thompson, *op. cit.* It is also possible that the malaria position was aggravated by this means.
2. *Surra* is a trypanosomiasis of domestic animals, borne by *T. evansi.* It is most prevalent in south Asia, but is also found in Africa and Madagascar. The mode of its introduction is not known, but it is certain that the animal population of Mauritius had no immunity to the disease before 1902.

the draught bullocks used to draw cane from field to mill. This disaster precipitated the introduction of cane railways, which had previously been employed on only a few estates. By 1904 cane railways had become widely established and, by making longer hauls from field to mill more economical, placed a premium on large-scale operation. It also facilitated the rapid concentration of factory operations into a smaller number of better equipped mills.[1] The effect was to substitute consolidation of estates for fragmentation.[2]

Urbanization

Urban settlement in Mauritius is as old as the colony itself; in the eighteenth century rural settlement was merely subordinate to the port. As agriculture became more important, however, the relative importance of Port Louis declined. In the seventeen-eighties the capital held one-third of the population, in 1817 a quarter, and in 1846 three-tenths. Thereafter the proportion fell to only a fifth in 1871.

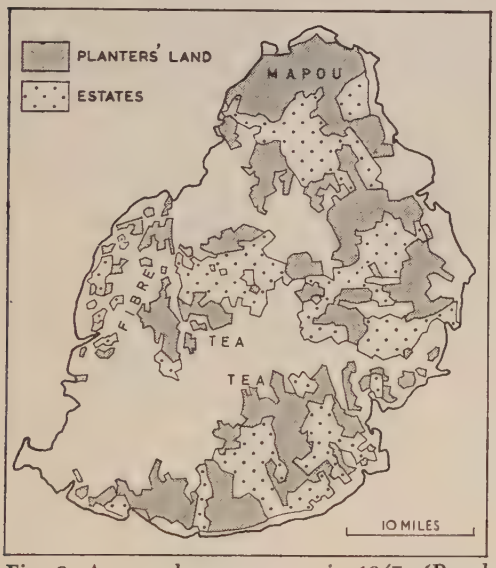

Fig. 8. Area under sugar-cane in 1947. (Based on a map in the *Report of the Mauritius Economic Commission,* Port Louis, 1949).

Port Louis was the only town until 1806 when Mahebourg was established as a second naval base on the south-eastern harbour. Until after the eighteen-sixties Mahebourg remained the second town in the island, with a garrison and a small white population, but it never became an independent seaport. After the advent of malaria Mahebourg suffered along with the capital.

There was some suburban growth from Port Louis into southern Pamplemousses by the eighteen-fifties and the completion of the northern and central railways in the eighteen-sixties would in any case have led to some extension of this development. As already noted the advent of malaria both accelerated the suburban movement and also directed it firmly onto the central line (Fig. 9, A, B and C).

The size of the urban population remained static from 1881 to 1901, but the decline of Port Louis and the rapid growth of the Plaines Wilhems towns

1. The number of factories had already fallen from a peak of 259 in 1858 to 124 in 1891. However, in 1904 an outside observer described Mauritian sugar factories as 'patch-work concerns, compounded out of two or three small factories, with machinery fit only for the scrap-heap.' N. Deerr, 'The sugar industry of Mauritius', *Sugar Journal and Tropical Cultivator* (Brisbane, 1904).

2. There were also important financial causes and consequences of fragmentation that are of some significance. Heavy indebtedness, and the withdrawal of capital by Franco-Mauritians who migrated to France, may also have been a part-cause of the Indian acquisitions. Then, as later, estates lacked working capital and obtained it from a *bailleur de fonds,* generally a merchant or produce broker, and frequently a Muslim. The *bailleur de fonds* became, in effect, the business manager of the estate and controlled the marketing of sugar. In some respects, therefore, the position of estate proprietor, small planter and *métayer* alike showed many similarities. *Mauritius Royal Commission, 1909* (1910); Sir F. Watts, *Report on the Mauritian Sugar Industry* (London, 1930); Colonial Office, *Report of the Commission on the financial situation of Mauritius* (London, 1932).

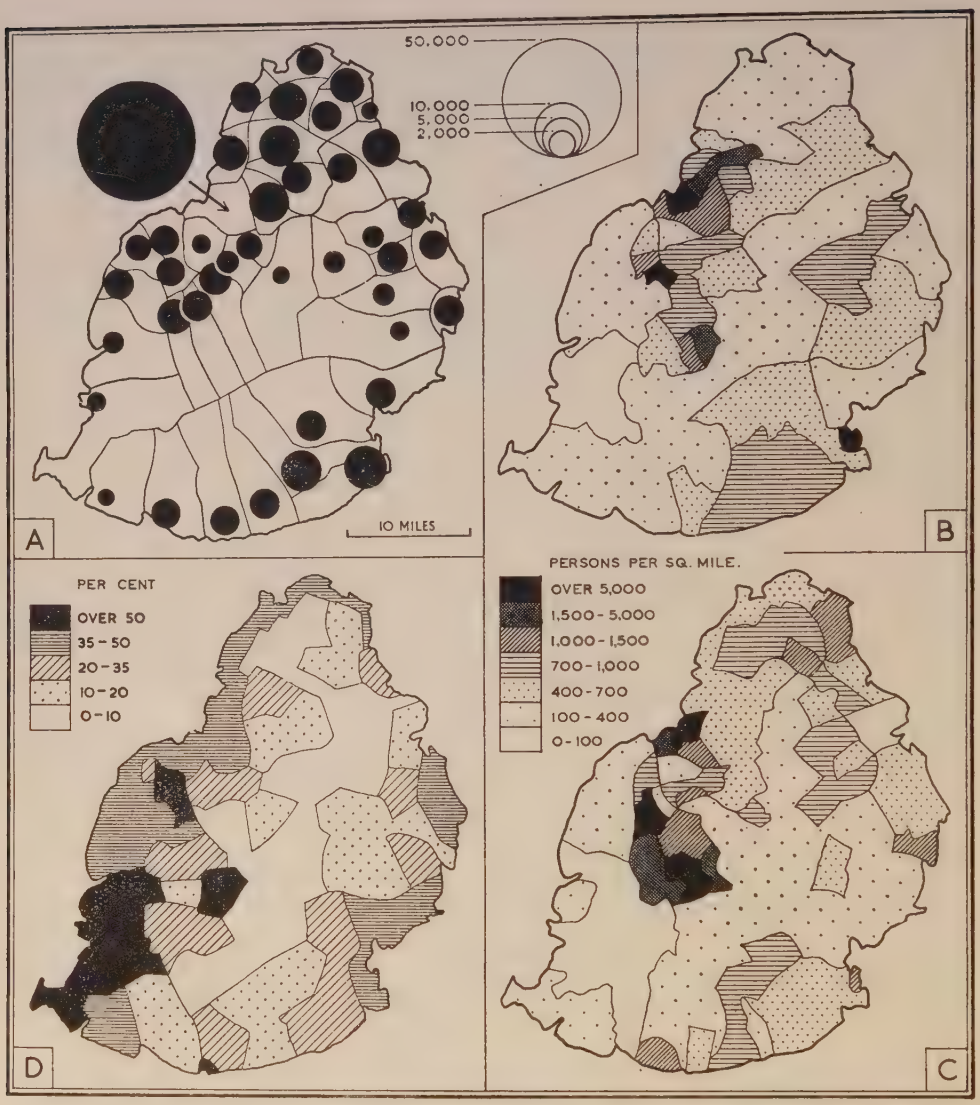

Fig. 9. The changing distribution of population. A. 1851 (by census blocks); B. 1881 (by census blocks); C. 1952 (by census blocks); D. Relative distribution of the General Population in 1952 (by locality groups).

led to considerable redistribution. In the present century, however, the towns have experienced steady growth, while the population of the rural areas actually declined to 1944.[1] Between 1944 and 1952 town and country both gained, but by only 12.9 per cent in the rural areas and by 28.7 per cent in the urban areas.

The ethnic composition of the urban population has changed in such a way as to increase the Indian proportion. In 1851 no less than 78·3 per cent of the

1. The 32,000 loss in Table 1 is exaggerated by the taking in of additional 'urban' areas in the computations for later censuses.

TABLE 1: URBAN AND RURAL POPULATION

	1881	1901	1911	1931	1944	1952
PORT LOUIS	66,625	52,740	50,060	54,435	65,201	82,582
MAHEBOURG	4,483	4,810	5,735	7,698	9,816	13,773
P. L. SUBURBS*	5,731	3,440	2,675	6,466	4,124	7,701
PL. WILHEMS**	15,550	32,515	50,846	70,556	103,727	131,218
URBAN	92,389	93,505	109,316	139,155	182,868	235,274
RURAL	267,485	277,518	261,077	254,083	235,474	265,926
PERCENTAGE URBAN	25·7	25·2	29·5	35·4	43·7	46:9
OF TOTAL URBAN:						
PERCENTAGE IN PT. LOUIS	72·1	56·5	45·8	39·1	35·7	35·1
PERCENTAGE IN PL. WILHEMS	16·8	34·8	46·5	50:7	56·7	55·8

Note: In this table an attempt is made to define the actual urban area at each date. Port Louis at all dates includes the whole town and district, but for 1881 to 1931 inclusive the remainder of the figures are for assemblages of census blocks (census localities in 1911), and change from date to date, with changes in the urban area. For 1944 and 1952 exactly comparable locality groups were employed, using the locality data given in these two censuses. These are the only two dates in which the same area is employed, at the cost of including a small non-urban area in 1944. 1944 and 1952 figures for Port Louis are both adjusted slightly from the census totals for the district.

* Includes that part of Pamplemousses immediately north of the city, and, at later dates, an area in Moka, Plaines Wilhems and Black River around the mouth of the Grand River Northwest.

** Urban areas only. Initially, Rose Hill and Curepipe only. For 1944 and 1952 all areas marked as urban on Fig. 1.

From the point of view of reliability in urban area delimitation, the above figures fall into this order: 1952, 1944, 1911, 1881, 1901, 1931. The last is very unreliable in detail.

population of Port Louis belonged to the General group. In 1911 the General Population formed 51.6 per cent of the whole urban total and in 1952 only 41.6 per cent. It should again be emphasised that these ethnic proportions are very dangerous to use, and a clearer picture is obtained from Tables 2 and 3.[1]

The greatest increase in urbanization has been among the Muslims and the Chinese; the Hindi, Tamil and Telugu speaking Hindus remain essentially rural in distribution, though large numbers of them, and also large numbers of Christian Indians, are concentrated in the semi-urban fringe of the Plaines Wilhems towns. The most highly urbanized groups are the Gujerati Indians, the Chinese, and the élite among the General Population.

There are some important internal differences between the several urban areas. Port Louis is very much more densely peopled than the Plaines Wilhems

1. The General group has been gaining additions by inter-marriage and conversion from the other groups from the beginning. The census, however, has never reflected the position wholly accurately as successive Census Commissioners have withheld sometimes all descendants of non-General fathers, sometimes all persons with non-European surnames, from inclusion in the General population. In the last three censuses there have been great variations in practice. In 1931, and to an even greater extent in 1944, most of the 'doubtfuls' were put into the General group so that between 1931 and 1944 the enumerated Indian group actually declined despite general population increase. In 1952 the former position was largely restored and many persons, enumerated as General group in 1944, were returned to the Indian and Chinese groups. It may be added that none of the three census reports provides any real information on the basis of classification employed, or any adequate comment on the resulting distortions. Nor has it been possible to obtain any full explanation of the 1952 changes.

TABLE 2: PERCENTAGE OF THE POPULATION BY PRINCIPAL RELIGIONS WHO RESIDED IN PORT LOUIS AND PLAINES WILHEMS, 1901 AND 1952

	1901 PER CENT	1952 (a) PER CENT	1952 (b) PER CENT
CHRISTIAN	52·7	64·6	54·4
BUDDHIST & CONFUCIAN	45·2	69·5	65·5
MUSLIM	29·5	52·2	43·2
HINDU	19·0	31·1	19·5

1901 Total of the two districts
1952(a) Total of the two districts
1952(b) Port Louis plus the Plaines Wilhems towns only.

towns or Mahebourg, and has at its heart an area of declining population, resulting from the rapid commercial expansion of recent years. Port Louis has none of the *dix-mille,* but a high proportion of the Chinese, and the wealthy endogamous Muslim and Gujerati groups. Its Indian population, dominantly Muslim, is also largely *Creole* speaking. Within its small compass the city has distinct and sharply bounded Muslim and Chinese quarters. Such intense clustering is not paralleled elsewhere, though Beau Bassin and Rose Hill have a high concentration of the *gens de couleur* and the Forest Side and Floreal districts of Curepipe are essentially 'white'.

The Elimination of Malaria

The four elements discussed above—the spread of sugar cultivation, malaria, fragmentation and urbanization—largely shaped the distribution of population as

TABLE 3: PERCENTAGE SPEAKING CERTAIN LANGUAGES IN EACH ETHNIC GROUP (OVER 3 YEARS OF AGE) WHO RESIDED IN PORT LOUIS AND THE PLAINES WILHEMS TOWNS, 1952

	PORT LOUIS PER CENT	PLAINES WILHEMS TOWNS PER CENT	TOTAL NUMBER IN MAURITIUS
GENERAL POPULATION:			
FRENCH	19·5	57·1	34,160
CREOLE*	22·8	23·3	99,254
INDO-MAURITIAN POPULATION:			
FRENCH	32·4	46·2	1,648
CREOLE & FRENCH	31·3	24·9	95,813
GUJERATI	61·0	29·3	796
URDU	11·4	13·3	11,791
HINDI	3·2	7·7	174,409
CHINESE POPULATION:			
CREOLE	60·7	20·4	4,287
CHINESE	47·2	21·1	11,260

* *Creole* is a slave-modified form of French, incorporating some African and Malagasy words and grammatical forms. In various forms, it is the *lingua franca* of Mauritius, the Mauritius dependencies and the Seychelles. The Creole spoken by the Indians is to some extent Hindi-ised, but is none the less gaining currency over Indian languages in the towns though not in the rural areas. The distinction drawn here between French and Creole speaking is dubious; what is more important is that this is the distinction between those who *claim* to speak French and those who admit use of Creole.

it stood at the time of the 1944 census. In the eight years that intervened between 1944 and the census of 1952, however, a fundamental change took place. By draining and other anti-larval works between 1943 and 1948, and by DDT spraying between 1948 and 1951, malaria was eliminated, and had ceased to be an important cause of sickness and death by 1949. At the same time an economic boom led to the renewed spread of sugar cultivation, to the establishment of tea on the central uplands on a much wider scale than hitherto, to a widening in the small industrial sector of the economy and to a great boom in tertiary activities. Even in a few years, these changes had a considerable effect on the pattern of population distribution (Fig. 10).[1]

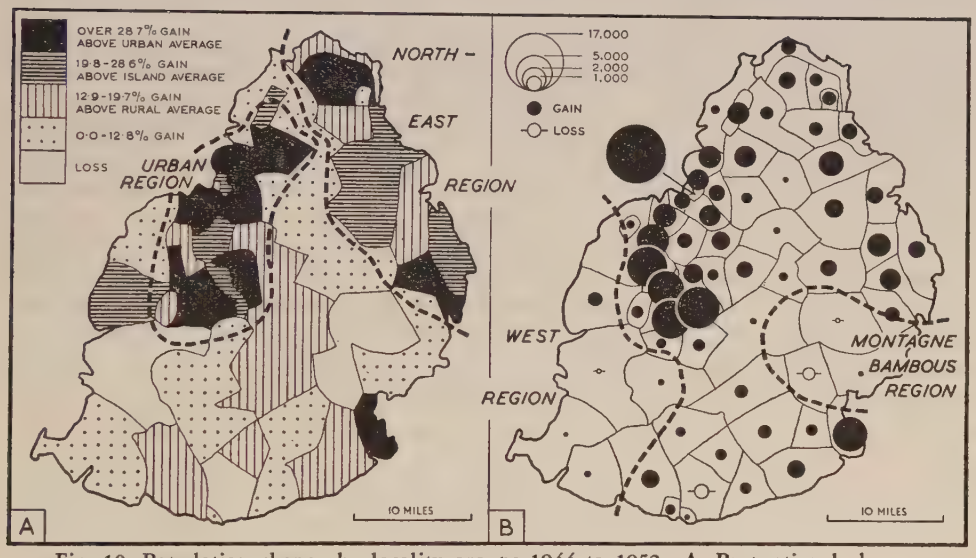

Fig. 10. Population change by locality groups 1944 to 1952. A. Proportional change; B. Absolute change.

The largest gains were in the periphery of the towns. In Port Louis with its lowland suburbs the gain averaged 3.8 per cent per annum, and in one block of the city it was just over 10 per cent per annum. The lower Plaines Wilhems towns also gained substantially, while increases of around 30 per cent in parts of Pamplemousses are also related to the general area of growth in the region of the capital.

Curepipe, on the other hand, grew very little. The rate of growth for this town has been slowing for some years, and even between 1952 and a special census held in 1955[2] the population grew by 329 less than the recorded natural increase. In the malaria period Curepipe benefited from its immunity, but this is no longer significant. Curepipe is cool, damp, and unpleasant by comparison with warmer places below 1,200 feet, and despite the development in Curepipe of the

1. Change in distribution was analysed from the locality data in the two censuses. The localities did not remain constant, and hence had to be grouped into comparable areas, running boundaries as far as possible through open sugar country or unoccupied areas. These grouped localities are the basis of this analysis.

2. This was a special census held by the Town Council because of their dissatisfaction with the results of the 1952 census. I am indebted to Mr. M.V.M. Herchenroder for this information. In my examination of the locality data for 1944 and 1952 I found an increase of only 495 in Curepipe and environs.

inland's only attractive commercial centre there may be some tendency to desert the superhumid uplands in search of greater bodily comfort.[1]

Population increase in the rural areas away from the direct influence of Port Louis is sharply concentrated in the north-east, particularly in Riviere du Rempart. This district has shown persistent natural increase for a long period—a phenomenon that will receive more notice below. Sugar has recently enjoyed a renaissance here, and it is now classed as the best land in the island. There were also smaller increases on the southern part of the central upland, where tea planting has been firmly established since the war. However, the northern part of the central ridge is an area of small gain.

The whole south and west of the island except Mahebourg and its environs has gained little. Indeed, in the four coastal districts Flacq, Grand Port, Savanne and Black River, the size of the male population of working age (15-64) was smaller in 1952 than in 1944 (Table 4). There were substantial areas of stagnation or decline in the south and west. The topographically compartmented country around the Montagne Bambous, remote from the main lines of circulation, has lost substantially, while in the sub-humid west, together with western Savanne, a total gain of only 1,196 was almost wholly (1,038) concentrated in the single locality group of Medine—an irrigated sugar district. South of a line drawn from central Black River to central Flacq lies over 50 per cent of the island's area, but within it only about 19 per cent of the intercensal population increase was experienced. This is the 'back of the island'—the area remote from the port, its services, its employment, and its well developed system of circulation.

TABLE 4: SIZE OF WORKING MALE POPULATION

	MALE POPULATION OF WORKING AGE, 1952, AS A PERCENTAGE OF:		TOTAL IN OCCUPATIONS, 1952, AS A PERCENTAGE OF: 1944
	(A) 1882	(B) 1944	
PORT LOUIS	93	118	119
PAMPLEMOUSSES	75	100	105
RIV. DU REMPART	128	108	99
FLACQ	73	97	94
GRAND PORT	73	99	95
SAVANNE	69	96	99
BLACK RIVER	61	92	91
MOKA	68	112	106
PLAINES WILHEMS	249	129	120
MAURITIUS	100	111	109

1. There is also a tendency among the wealthy to extend their annual stay in the seaside *campements* from a short winter season to the larger part of the year, excepting only high summer. The *campements* are private cottages scattered through the more attractive parts of the casuarina (*filaos*) planted reserve strip around the coast. Nearly all the élite, white and non-white, have *campements* which vary greatly in style from seaside cottages to fully furnished houses, duplicating in equipment the owners' Curepipe houses. With a car, it is possible to live in the *campements* while working in Port Louis, and residence on the lagoon shores has many attractions.

THE MECHANISM OF DISTRIBUTION

The Contribution of Fertility and Mortality

The general outline of changing distribution, and the broad pattern of environmental and historical factors bearing upon it having been established, it now remains to enquire into the 'mechanism' by which the distribution has been produced. This must involve an inquiry not only into migration and circulation of people, but also into the demographic characteristics of the population, for fertility and mortality have never been uniform over the island and the very substantial variations that have existed have exerted considerable effect. There are variations between the several ethnic groups, and these have distributional significance in view of the uneven spread of the different groups over the island. There are also regional variations *per se* in both fertility and mortality, closely influenced by the conditions of the geographical environment.

In 1955 a Net Reproduction Rate of 1.962 for the whole population underlay a Gross Reproduction Rate of 2.545. The latter rate varied among the groups as follows: Chinese 2.786, Indo-Mauritian 2.588, General 2.434.[1] The significant difference in fertility lies principally in the age of marriage and childbearing:

	General	*Indian*	*Chinese*
Percentage of women aged 15 plus, returned as mothers:	56.3	73.6	64.8
Percentage of women aged 45 plus, returned as mothers:	68.4	80.2	81.8

Average size of completed family ranged only between 5.43 and 5.58. Though data is lacking for earlier periods, it seems likely from the evidence of child/woman ratios that the differential between the General and other groups was wider in the past. Similarly, the General group has almost always enjoyed lower mortality than the Indo-Mauritian and Chinese groups since approximate age-sex normality was achieved among the latter groups. These differentials have an important geographical effect, since the General population is so largely concentrated into the leeward coast, including Port Louis and Plaines Wilhems (Fig. 9D).

Tables 5, 6 and 7 provide, in summary form, an impression of such geographical differentials in fertility and mortality as may be discerned.

It is readily apparent that the windward side of the island has showed higher child/woman ratios and crude gross reproduction rates, and generally lower crude death rates than the leeward side. Between upland and lowland there was a very sharp distinction in the incidence of malaria, and a rather less sharp division in general death rates. There is no clear higher fertility pattern on the uplands, perhaps because of the weight introduced by the large General population in Plaines Wilhems. It is even less easy to discern any clear rural/urban contrast. The child/woman ratios for Port Louis and Plaines Wilhems are themselves contrasted, due to the sharply contrasted mortality conditions of the two areas.[2]

1. These rates were computed by the writer from the results of the first six months' recording of births by age of mother in 1955, and female population by cohorts estimated by applying 1952 life-table values to the corresponding cohorts in the 1952 census. 1952 life-table rates were used in computing the net reproduction rate. These values are therefore approximate.

2. It should be emphasised that to treat the whole of Plaines Wilhems as 'urban' is a statistical necessity (there being no separate statistics for the towns until 1944 and 1952, and even then these are not really comparable), but cannot be justified on other grounds. The areas classed as actually 'urban' in Table 1 comprised the following percentages of the total population of the district: 1881, 33.6 per cent; 1911, 74.9 per cent; 1944, 85.9 per cent; 1952, 87.7 per cent. In a still stricter sense, perhaps only Curepipe, Beau Bassin and Rose Hill and part of Quatre Bornes should be classed as fully urban.

TABLE 5: APPROXIMATE GROSS REPRODUCTION RATES*

	1911	1921	1931	1944	1952
PORT LOUIS	2·2	2·2	2·1	2·1	3·1
BLACK RIVER	2·2	1;8	1·2	1·7	2·9
PAMPLEMOUSSES	2·3	2·5	1·5	2·2	3·2
RIV. DU REMPART	3·0	3·1	2·0	3·2	4·1
FLACQ	2·4	2·3	1·7	2·2	3·3
GRAND PORT	2·4	2·1	1·8	2·1	3·2
SAVANNE	2·8	2;2	1·9	2·2	3·1
MOKA	2·8	2·7	2·1	2·6	3·0
PL. WILHEMS	2·4	2·5	2·3	2·3	2·9

* Number of girls that, with current fertility, would be born to one woman throughout her reproductive life. In this computation, births were distributed by age of mother according to 1955 experience (the first figures available) for 1944 and 1952. For earlier dates these were rounded as follows: 15-19 = 15 per cent; 20-29 = 53 per cent; 30-34 = 20 per cent; 35-44 = 12 per cent. Births in Mauritius must be registered in the district in which they occur.

Furthermore, complications due to ethnic composition also enter. Though the 'urban' child/woman ratios are lower than the rural at all dates for the General and Chinese populations, the reverse is true of the Indo-Mauritians except only in 1881 and 1952. The large proportion of Muslims, especially in Port Louis, and the presumed high fertility of the peri-urban Hindus and Christian Indians in Plaines Wilhems may both be invoked to explain this. If we seek evidence of true urban low-fertility patterns we can probably not go beyond Curepipe and Rose Hill-Beau Bassin, towns in which a high proportion of the professional and clerical classes are concentrated.

Problems are also presented by a closer examination of the coastal areas. While the district of Black River, the first, worst, and last malarial district of the

TABLE 6: CRUDE DEATH RATES, BY DISTRICT, AND SPLEEN RATES AS DETERMINED BY ROSS (1908)

	AVERAGE CRUDE DEATH RATES				SPLEEN RATE*
	1905-06	1938-42	1943-47	1950-54	1907
PORT LOUIS	56·5	27·2	25·3	15;5	35·6
BLACK RIVER	44·2	37·1	37·5	18·0	58·2
PAMPLEMOUSSES	46·1	30·7	43·6	15·8	45·7
RIV. DU REMPART	39·7	25·4	26·7	14·7	27·6
FLACQ	42·4	29;2	30·4	14·8	62·7
GRAND PORT	38·6	34·0	35·4	18·4	42·2
SAVANNE	32·5	32·3	32·6	16·7	23·0
MOKA	31·1	25·6	30·1	15·2	11·2
PL. WILHEMS	31·9	22·1	20·8	13·1	14·3

* The Spleen Rate is the rate per 100 persons examined showing enlarged spleen, which is a mark of chronic malarial infection.

TABLE 7: CHILD/WOMAN RATIOS (Children 0.4 Per 1,000 Women 15-44)

	1881	1911	1931	1944	1952
PORT LOUIS	501·45	438·45	467·63	480·54	714·08
PL. WILHEMS	631·82	587·17	161·04	520·03	719·66
REMAINING DISTRICTS	680·5	558·9	535·3	520·8	889·0
LEEWARD COASTAL*	538·8	483·7	490·0	490·5	790·1
WINDWARD COASTAL*	694·8	559·1	537·9	527·8	884·6
UPLAND*	683·9	592·4	612·1	517·5	741·5
CUREPIPE	—	—	—	478·08	602·49
BLACK RIVER	574·19	502·43	478·79	395·25	824·93
RIV. DU REMPART	797·92	685·14	585·37	666·22	994·04

* Leeward coastal: Black River, Port Louis, Pamplemousses
Windward coastal: Riviere du Rempart, Flacq, Grand Port, Savanne
Upland: Moka, Plaines Wilhems.

island, has frequently shown highest mortality and lowest fertility,[1] there are also pockets of ill health on the windward side, while one area, the district of Rivière du Rempart, stands out strikingly with the highest fertility in the island and with mortality far below that of the rest of the coastal belt.

Again, we must invoke a complex of factors. Though Rivière du Rempart is the most low-lying district in the island, it has little standing water, is almost entirely open, and has a low water table which has both facilitated drainage and encouraged the replacement of well water by piped supply. It is also suggested that the standard of cleanliness is higher here than in other parts of the windward slope.[2]

The Contribution of Internal Migration

The effect of these variations in fertility and mortality can only be correctly evaluated if account is taken of internal migration. Unfortunately, there are no direct data whatever bearing on this subject, but an attempt was made to obtain a guide to the probable scale of migration by comparing the Registrar-General's estimates for the population of each district, which are based on the previous census plus births and minus deaths, with the subsequent census. This was done for each intercensal period from 1901. Extensive corrections were necessary in order to obtain comparability,[3] but there emerged for each district a 'local

1. P.A. Wilson, *Report... Nutritional Investigations..* (1946), demonstrated amply the close coincidence of malaria and malnutrition. On p. 15 it is noted that 'In spite of eating more animal food in the form of fish, children in the coastal belt where there is high incidence of malaria show more frequent signs of malnutrition', and on p. 31 'The higher the incidence of malaria, the higher the incidence of deficiency states.' It might have been added that hookworm and the other helminthiases, dysentery and other enterical complaints and (for a different reason, namely water temperature for the host snail) bilharzia are all most common in the malarial areas. There existed a close interrelationship between deficiency states, malaria and the other endemic diseases, due largely to the high calorie loss involved in malaria and the helminthiases.
2. I am indebted to Dr. Burton Benedict for some local details pertaining to this problem.
3. These corrections included: (1) the adjustment of the Registrar-General's estimates to census date, where this information was not available, by adding and subtracting a proportion of the births and deaths within census year; (2) the elimination of overseas migration; (3) the elimination of foreign military, especially in 1944, and to add in, with assumed distribution, the Mauritian Pioneers serving overseas (this was done to bring the *de facto* census on to a *de jure* basis, comparable with the Registrar-General's *de jure* figures); (4) to eliminate, by spreading, the total error in registration, which was generally substantial. This degree of correction, particularly the last, introduced numerous fresh sources of error. Hence the results presented here can only be the crudest approximations.

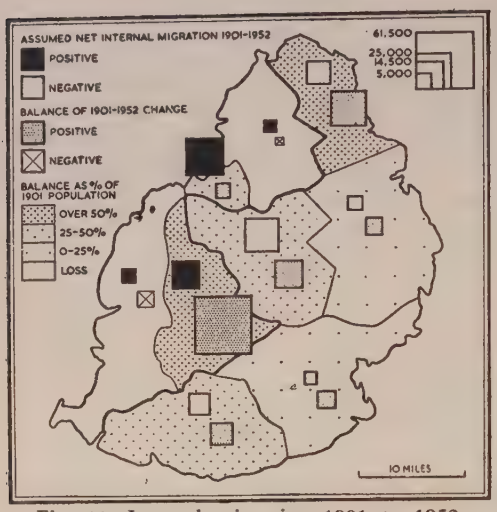

Fig. 11. Internal migration 1901 to 1952.

difference' between the two sets of figures which was presumed to yield some indication of internal migration. The residue obtained by subtracting this 'local difference' from the total intercensal population change also provided some estimate of the contribution of natural change with overseas migration. The net 51 year result, stated in round terms on Fig. 11, is startling in its simplicity and this simplicity shows that the method has a rough validity. The four windward rural divisions and Moka each had a positive 'natural change' and served as sources of out-migration. In Moka the out-migration over the 51 years 1901-52 exceeded the large natural increase by over 7,000, thus bringing about the steady decline in population since 1900 noted on p. 6. Rivière du Rempart also had a very large 'natural increase' but exported a major part of it.

On the leeward side of the island, by contrast, the two rural divisions of Pamplemousses and Black River each had 'natural decreases' and received inward migration. Migration was insufficient to stem the total decline in Black River, but permitted a small actual increase in Pamplemousses. Port Louis had a small growth from 'natural change plus overseas migration' (probably largely from the latter), but its main accretion has been from internal migration. The capital is, in fact, the main recipient of this migration. Plaines Wilhems, on the other hand, has gained largely by 'natural change' and has received a suspiciously small migration. Some doubt must be cast on this result, though it is not impossible.

Crude and inaccurate though this picture is, its broad lines both confirm and are confirmed by the whole of the preceding analysis of fertility and mortality. Large natural increase in the uplands and in Rivière du Rempart, natural decrease in the leeward coastlands, and the contrast between Port Louis and Plaines Wilhems all emerge clearly. Internal migration appears to be essentially a movement from the windward to the leeward side of the island, from the surplus to the deficit areas. Without migration, there would have been a rapid build up of population on the central plateau and in the north-east, coupled with a decline on the leeward side. Migration has operated to even out these demographic variations while at the same time permitting substantial urban growth in the unhealthiest part of the island.

Population Distribution, Circulation and the Mauritian Economy

This discussion began with the relation of the distribution pattern to the economic development of the island, and it now returns to its starting point. In varying the distributional pattern produced by natural change, internal migration acts largely in response to the labour needs of the economy. In the rural areas both the broad and the detailed distribution of population are still broadly governed by the sugar industry. Where sugar cannot be grown, there is no population. The only real exception to this is in the south-west, where there is some subsistence maize farming and fibre-cutting. Even the new tea plantations on the uplands have created no new settlement; they draw their labour from outside. The overwhelming majority of rural Mauritians live amid sugar cane, and there is a

sharp contrast between the sugar country, with its crowded villages, and the high emptiness of the south-western tableland and the gorges.

To what extent the internal migration of population may be correlated in detail with the needs of the sugar industry is problematic. The demand for labour in Pamplemousses and northern Black River was increased by the extension of the irrigation schemes. At the same time the area under sugar declined somewhat until recent years in the uplands, and this may have been the main factor in producing emigration from Moka. Costs of production are higher and the yield of cane lower in the super-humid areas, where heavily leached soils require more fertilizer and excessive cloud cover holds back the growth of cane.[1] However, neither locally nor in general is the distribution of sugar industry labour exactly suited to the needs of the industry. Only about 33,000 people now reside in the estate camps, and estates and planters alike draw the bulk of their labour from nearby villages. Most labour is employed on a daily basis, frequently in regular gangs, though at crop time, when the labour requirement is some 20 per cent higher, additional labour is obtained by the recruiting *sirdar* often from a greater distance.

Most village labourers walk to work, but between 8 and 10 per cent of the whole labour supply of the estates has to be brought in from a distance—a cost that is always borne by the employer[2]. Table 8 summarizes the position on the estates in the crop season of 1953.

TABLE 8: SUGAR ESTATES: TOTAL FIELD LABOUR EMPLOYED, AND LABOUR RECRUITED IN THE PLAINES WILHEMS TOWNS BETWEEN 29/6/1953 AND 31/12/1953

	AVERAGE FIELD LABOUR PER DAY	PER ACRE PER DAY	IMPORTED FROM PLAINES WILHEMS: AVERAGE PER DAY
PAMPLEMOUSSES/RIVIERE DU REMPART	3,865	·21	NIL
MOKA/FLACQ	5,729	·29	354
PLAINES WILHEMS/BLACK RIVER	4,098	·36	1,242
GRAND PORT	6,611	·29	241
SAVANNE	4,574	·30	456
MAURITIUS	24,877	·29	2,293

Plaines Wilhems is the principal source of recruitment. Between one third and one half of its recruited labour goes only to Medine in central Black River, but a proportion is taken over 15 miles to estates in eastern Flacq and coastal Grand Port and Savanne. The only part of the island receiving no labour from Plaines Wilhems is the north, where, however, there is a substantial internal movement from Goodlands in Rivière du Rempart to estates in Pamplemousses and Flacq. Lorry-borne labour is also supplied from Mahebourg, the Moka villages and some few other larger villages.

These daily movements dispense to some degree with the need for permanent migration and permit a growing tendency towards concentration of rural population both into Plaines Wilhems and also into larger villages. In the rural north and

1. 'Efficiency of sugarcane production', *Mauritius Economic Commission (1948), Report, Part II (unpublished), Report of Committee No. 11* (Port Louis, 1949). The effect is on the cane yield, not on the sucrose content of the cane.
2. The small planters probably have to transport a higher proportion of their labour than do the estates. Statistics are collected only for the estates, however. Nearly all tea-planters' labour has to be transported.

north-east the large *morcellement* villages of Triolet, Goodlands and Brisée Verdière now have some 22,000 people.

This pattern of daily circulation of agricultural labour is overlain by the much larger daily commuter flow into Port Louis. Within the capital are concentrated almost the entire banking, commercial and wholesale activities and most of the manufacturing, other than sugar, in the colony. The city's labour force is supplemented by a heavy commuter flow from all the Plaines Wilhems towns and smaller flows from Pamplemousses, from the Moka villages and from northern Black River. The traffic is now handled almost wholly by bus, and between Port Louis and Rose Hill there is a bus every two minutes in the peak periods. Rose Hill and Curepipe are secondary centres of employment.[1]

The current demographic upsurge, which is likely to carry the population of Mauritius to over 625,000 by 1962 and probably over 750,000 by 1972[2] poses the question of the possible future distribution of population. Taking high and low estimates of the future population and assuming that, as now, only a third of the total enters economic activity, the population seeking work by 1980 could number between 260,000 and 320,000, in place of 165,000 in 1952. Extension of irrigation and the breeding of new cane varieties for marginal conditions, together with the extension of tea cultivation, may yield significant new employment opportunities in parts of the leeward coastlands and on the central uplands, but it cannot be expected that population increases in the existing body of the cultivated area will be matched by new employment on a comparable scale. Already the sugar industry's labour demand is largely satisfied, such local shortfall as exists being made up by daily transport.

It seems likely, therefore, that there will be a considerable increase in internal migration in the future, and that its direction—apart from some possible move to the uplands—will still be largely from east to west and particularly to the towns. Very rapid urban growth seems to be in prospect, and indeed it is probably only in the towns, if there, that anything like adequate new employment can be generated. The subject of the 'population problem' of Mauritius is beyond the scope of the present paper, but this examination does provide some pointers on its possible geographical incidence within the island.

ACKNOWLEDGMENTS

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1. The fact that the capital lies in the driest part of the leeward side of the island emphasizes a marked division between the areas supplying urban labour and those supplying agricultural labour. Port Louis itself supplies no field labour, and recruitment of agricultural labour from the Plaines Wilhems towns is, in fact, largely from the peri-urban fringe. Even Triolet in Pamplemousses, which is situated in a sugar area and has an almost wholly Indian population, supplies very little sugar labour indeed, but is a major source of labourers for Port Louis.
2. Mauritius Legislative Council, *Report of the Committee on Population, 1953-54.* Sessional paper No. 4, 1955, provides a comprehensive, if perhaps over-Malthusian, survey of the position. The population projection presented here is more conservative than the committee's projection; it is founded on 1955 age-specific fertility, which was distinctly below the 1952 peak rates used in the report.

THE RAINFALL OF MALAYA, PART I

By W.L. DALE

AS THE atmospheric temperature over Malaya is uniformly high all through the year there is no alternation of summer and winter as in temperate regions. Neither is it possible to divide the year into wet and dry seasons. Heavy rainfall may be experienced anywhere at any time of the year, and whilst short dry spells may occur, they are not sufficiently long and regular in their occurrence to warrant being called dry seasons.

Nevertheless, the climate of Malaya has a seasonal rhythm. The wind, more than any other climatic element, determines the seasons in Malaya. Changes in the direction and speed of the air-streams that cross the Peninsula are responsible for the division of the year, in most areas, into four seasons. The time of commencement and the duration of these vary slightly with latitude and from year to year.

There is, firstly, the north-east monsoon, when air-streams from the north-east sweep over the country. North-easterly winds, whose speed seldom exceeds 25 m.p.h., prevail from November or early December until March. Secondly, the north-east monsoon is followed by an inter-monsoonal or transitional season of five to seven weeks duration. This coincides approximately with the month of April in the south, and May in the north. During this short period the winds are either weak and variable, or reduced to a calm. Thirdly, sometime in May light south-westerly winds from the Indian Ocean advance across northern Malaya, and by June they become well established as the south-west monsoon. At the same time the southern part of the country experiences light southerly winds from the southern hemisphere. Both the south-westerlies and the southerlies persist until September or early October. These winds are weaker than the north-easterlies and are often subordinate to land and sea breezes in coastal districts. Fourthly, the south-west monsoon is followed by a second transitional period which coincides with October and early November. There are thus, in general, two monsoonal and two transitional seasons in each year.[1]

Over most of Malaya the general pattern of the wind seasons is reflected in the rainfall regime. The relationship varies, however, from place to place. In many parts a rainfall maximum coincides with each of the two transitional periods, and a minimum occurs sometime during each of the two monsoons. In other parts there may be only one maximum—occurring during one of the monsoons, and one minimum—occurring during the other monsoon. There are some places where one rainfall maximum occurs during a transitional season and another during a monsoon; in this case a minimum occurs in each of the monsoons and one monsoon has both a maximum and a minimum of rainfall.

Brief reference must also be made to the principal kinds of rainfall that occur in Malaya, as the rainfall regime is affected, to some extent, by the type of rainfall that is experienced, especially where local conditions favour a particular kind of

1. W.L. Dale, 'Wind and Drift Currents in the South China Sea', *Malayan Journal of Tropical Geography,* Vol. 8, 1956, Table 3 and Fig. 3, p. 24.

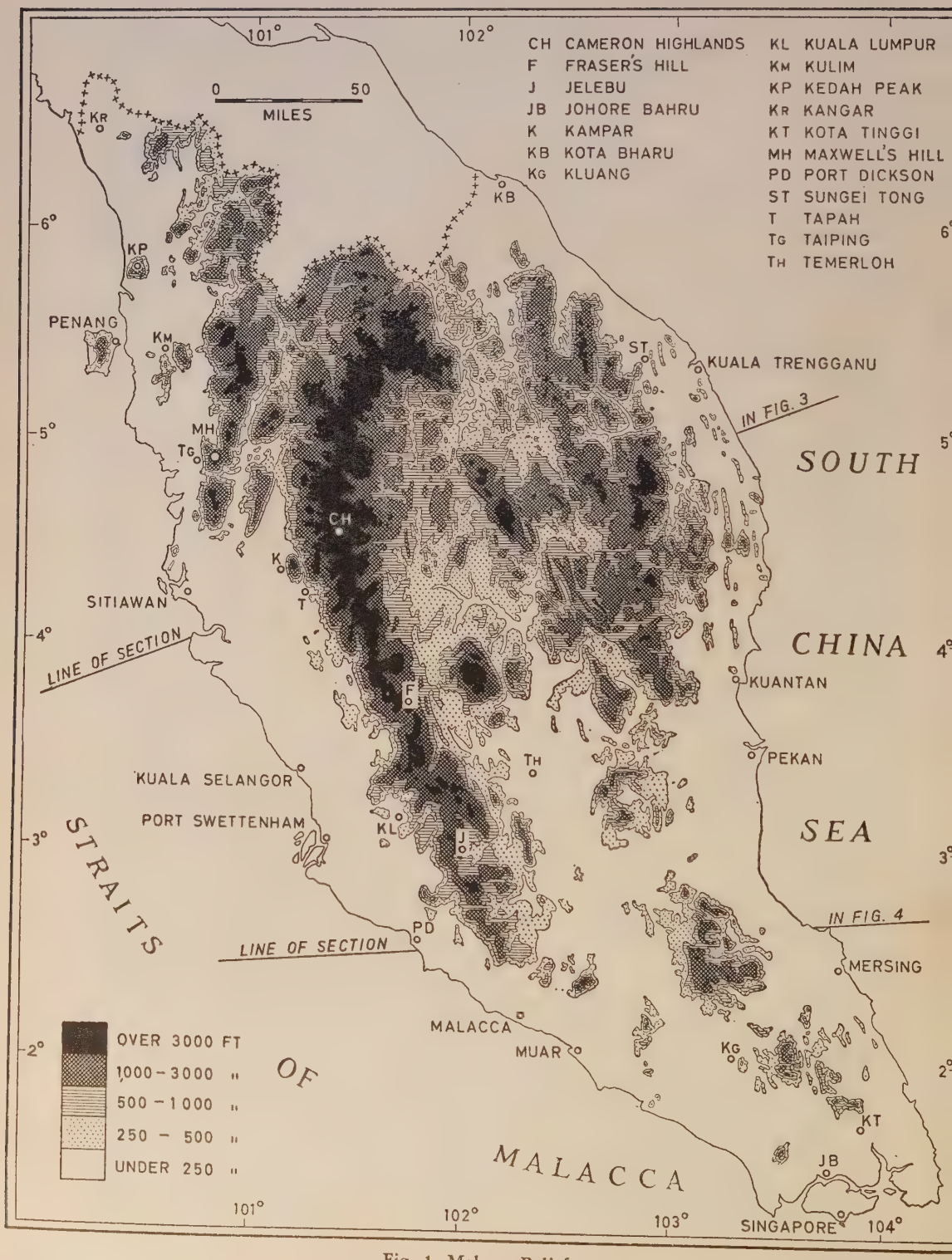

Fig. 1. Malaya, Relief.

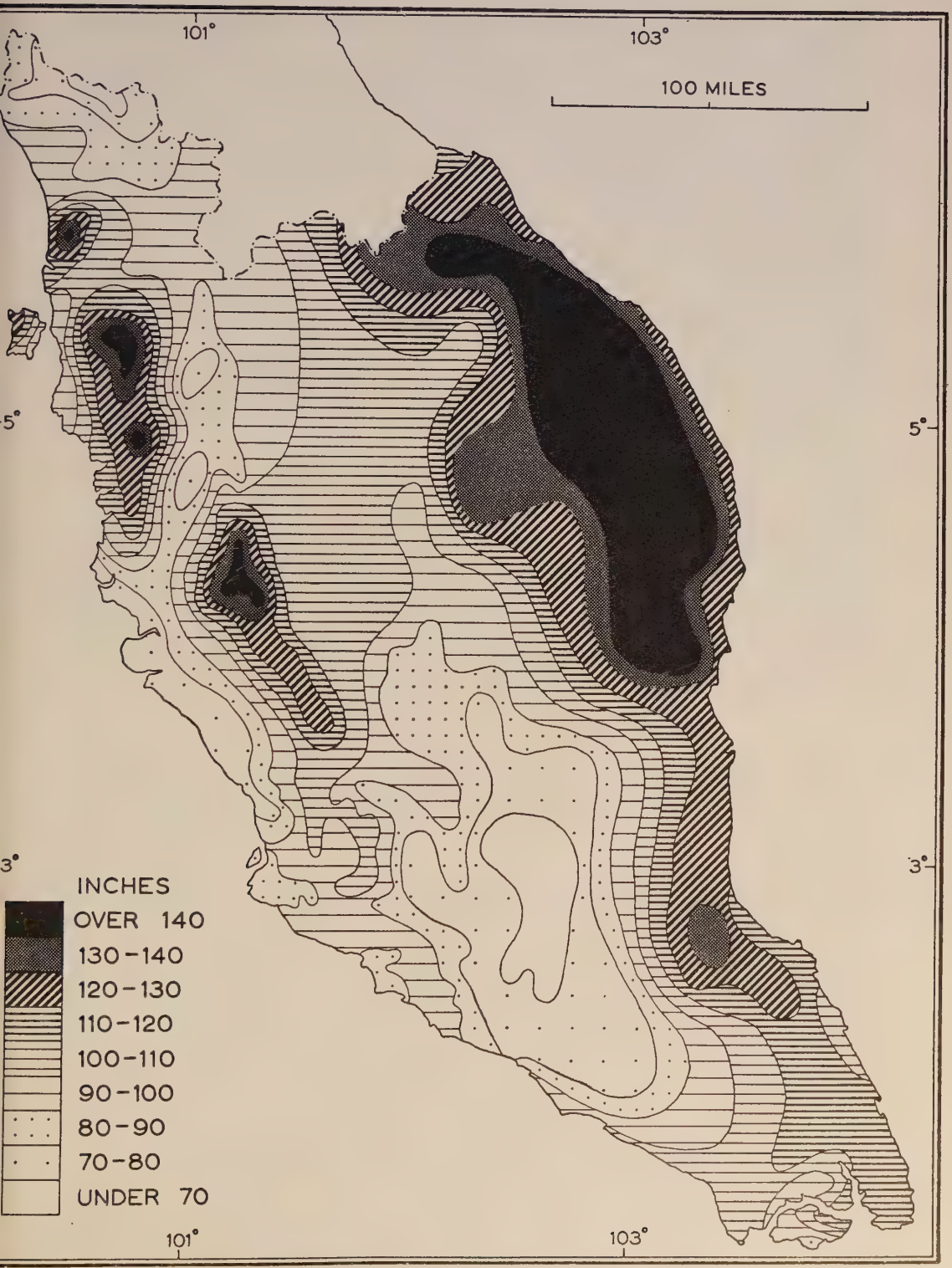

Fig. 2. Mean Annual Rainfall.

rainfall. Three main processes, effective singly or in combination, are responsible for different types of rainfall in the Peninsula.[1]

(1) The air-streams that approach Malaya have crossed one or other of the neighbouring tropical seas and are therefore warm and moist, and are conditionally unstable so that only slight uplift is necessary to produce condensation and precipitation. On crossing the land barrier of the Peninsula, sufficient uplift may be occasioned to produce heavy and extensive *orographic* rainfall, especially during the monsoons when the winds are stronger and able to achieve greater uplift.

(2) It is believed that at least seven air-streams from a variety of source regions flow across Malaya during the course of the year.[2] They come from different directions, and frequently two or more of them converge forming surfaces of discontinuity or air-stream boundaries where they meet. Convergence leads to up-currents followed by cloud development and large-scale formation of rain known as *boundary* rain.

Persistent and heavy rain of this kind frequently accompanies the onset of a monsoon. This is due to the slow movement of the boundary between the advancing and retreating monsoons so that boundary rain may continue for several days in any one locality.

(3) Due to the differential heating and cooling of the earth's surface beneath unstable equatorial air, convectional over-turning is an important process in low latitudes, and is responsible for heavy and frequent falls of *convectional* or *instability* rain. This type of rainfall is characterised by heavy showers of small areal extent and lasts for short periods of between one and six hours. As stated by Watts 'equatorial weather is local rather than regional. A single cumulonimbus cloud may produce heavy rain over an area varying from less than one square mile to twenty-four square miles.'[3] In such a shower the rate of precipitation may be as much as two to three inches per hour. Much of the rainfall in Malaya is of this type.

ANNUAL RAINFALL

The moist air-streams of the north-east and south-west monsoons cross Malaya transversely to the north-south lines of relief (Fig. 1), so that the distribution of rainfall (Fig. 2) reflects, to some extent, the major features of the topography.

There are, accordingly, two particularly wet belts; one running the full length of the country on the South China Sea side of the eastern mountains; and the other, confined to the northern part of Malaya, on the Malacca Straits' side of the western mountain ranges.

Apart from small isolated areas of high rainfall in the Larut Hills (east of Taiping) and Kedah Peak in western Malaya, the wettest part of the country is on the east, where the annual fall exceeds 110 inches throughout the entire length of the Federation of Malaya, and to a depth of between 25 and 100 miles inland from the east coast. The heaviest fall occurs on the foothills in Trengganu where an average of 160 inches is received per year. From Trengganu the annual

1. For a detailed account of rainfall types see I.E.M. Watts, *Equatorial Weather* (London, 1955).
2. I.G. John, 'The Properties of the Upper Air Over Singapore', *Memoirs of the Malayan Meteorological Service*, No. 4, Singapore, 1950.
3. Watts, op. cit., p. 17.

total decreases northwards to 120 inches at Kota Bharu, and southwards to 95 inches at Singapore.

In western Malaya the area receiving more than 110 inches per year is restricted to a narrow and discontinuous belt 200 miles long west of a line from Fraser's Hill to Kedah Peak.

The axes of the high rainfall belts do not, in general, coincide with the highest land, but rather with the foothills to the west and east of the mountains (Figs. 3 and 4). The axis of the western wet belt appears to approximate with

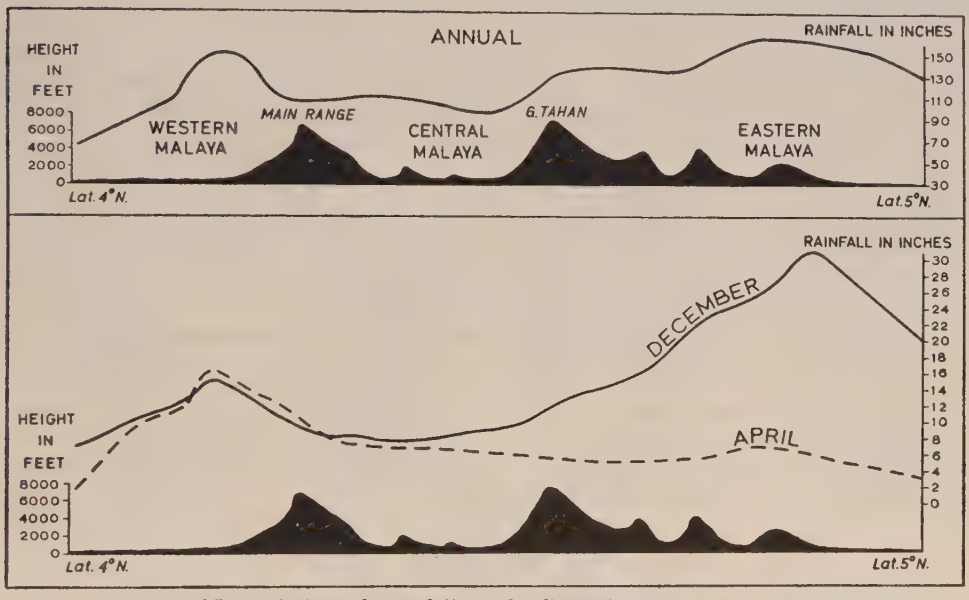

Fig. 3. The Relation of Rainfall to Configuration in northern Malaya.

an altitude of between 500 and 1,000 feet, beyond which the rainfall decreases with increasing altitude. The annual rainfall over the foothills and adjacent lowlands varies between 100 and 150 inches whilst at the summit of the Main Range it varies between 80 and 110 inches. Thus, for example, the annual fall at Kampar (128 ft.), on the lowlands, is 145 inches, but at Cameron Highlands (4,750 ft.), on the Main Range and only twenty miles to the north-east of Kampar, the annual fall is 104 inches.

The eastern wet belt covers the mountain slopes and foothills facing the South China Sea and extends across the lowlands to the coast. One of the wettest places in eastern Malaya is situated on the lowlands at less than 400 ft. above sea level and only 12 miles from the coast at Kuala Trengganu. This particular station, Sungei Tong, receives an annual rainfall of 169 inches.[1]

Drier, but by no means dry, belts extend from the west coast into the interior between the ridges of highland. Three such belts are clearly shown on Fig. 2; (1) central south Malaya—a broad belt extending for 175 miles north-westwards from Kluang; (2) the coast of Selangor and South Perak with an inland extension up the River Perak valley for 100 miles to the Thai frontier; (3) Perlis and north-west Kedah. In all these areas the average annual total is less than 90 inches.

1. Average for 10 years only.

The average annual rainfall for stations in lowland Malaya varies between 65 inches at Jelebu and 166 inches at Taiping. Over most of the country the amount varies between 80 and 130 inches. The lowest total for any one year at any station was 37.6 inches, recorded at Pekan in 1902,[1] and the highest for a low-level station was 204.7 inches at Taiping in 1914.

The station with the highest rainfall in Malaya is 'The Cottage' (4,513 ft.) in the Larut Hills near Taiping. The average annual total there is 232 inches.

The distribution of the rainfall in Malaya is remarkable for the way in which it varies considerably between places only a short distance apart and without intervening high land. For example, Kampar (128 ft.) and Sitiawan (23 ft.) are separated by 40 miles of lowland but their annual rainfall totals differ by 70 inches. Sitiawan near the west coast receives 75 inches, and Kampar at the foot of the Main Range receives 145 inches. Similarly, the two west coast stations of Port Swettenham and Kuala Selangor are only 25 miles apart but the annual total for Port Swettenham is 91 inches and for Kuala Selangor 73 inches, a difference of 18 inches.

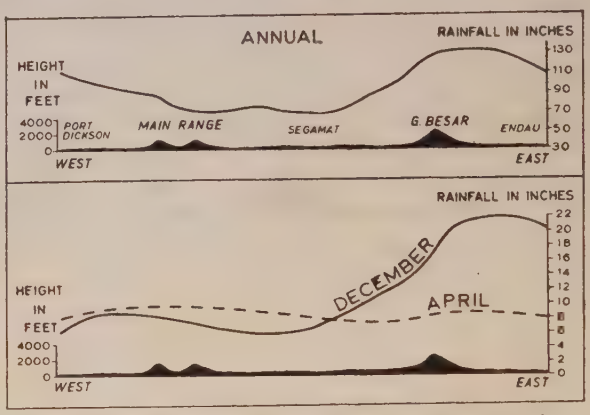

Fig. 4. The Relation of Rainfall to Configuration in southern Malaya.

MONTHLY RAINFALL

Figures 5, 6, 7 and 8 summarize the monthly rainfall distribution.

January is a wet month in eastern Malaya where the rainfall varies between 10 inches in the extreme north and south to 22 inches in Trengganu. The maximum fall is experienced within 15 to 25 miles of the coast on the maritime plain and the foothills of the eastern highlands. January is the wettest month of the year in southern Johore. Elsewhere, on the east, the January fall is considerably less than that for December, especially in the north—as at Kota Bharu where the December total is 26.09 inches and that for January only 9.84 inches.

In western Malaya most places receive less than 10 inches in January. The wettest part is in southern Perak where the foothills and lowlands west of a line from Fraser's Hill to Maxwell's Hill receive between 10 and 16 inches.

The driest parts of Malaya are: (1) Perlis, Kedah and western Upper Perak, and (2) the coastal strip between Port Dickson and Muar. In both these areas the monthly total is less than 6 inches.

February is a relatively dry month for Malaya as a whole. The heavy downpours that have gutted the east coast for three months (November, December and January) diminish remarkably in February, when the average rainfall on the Kelantan Plain is about 4 inches, and in Trengganu and coastal Pahang 6 inches

1. The average annual rainfall at Pekan is 127 inches.

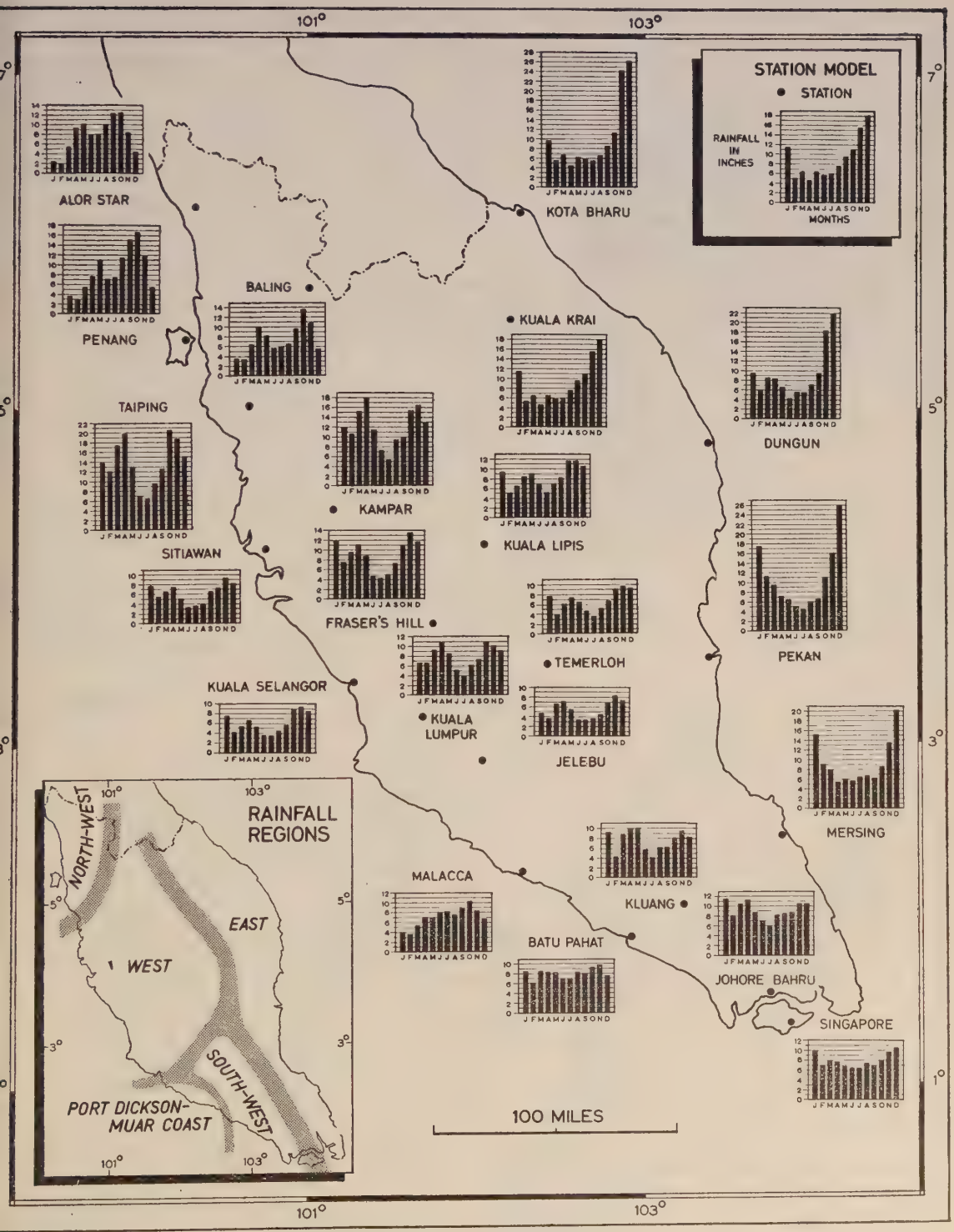

Fig. 5. Average Monthly Variation of Rainfall, and Rainfall Regions.

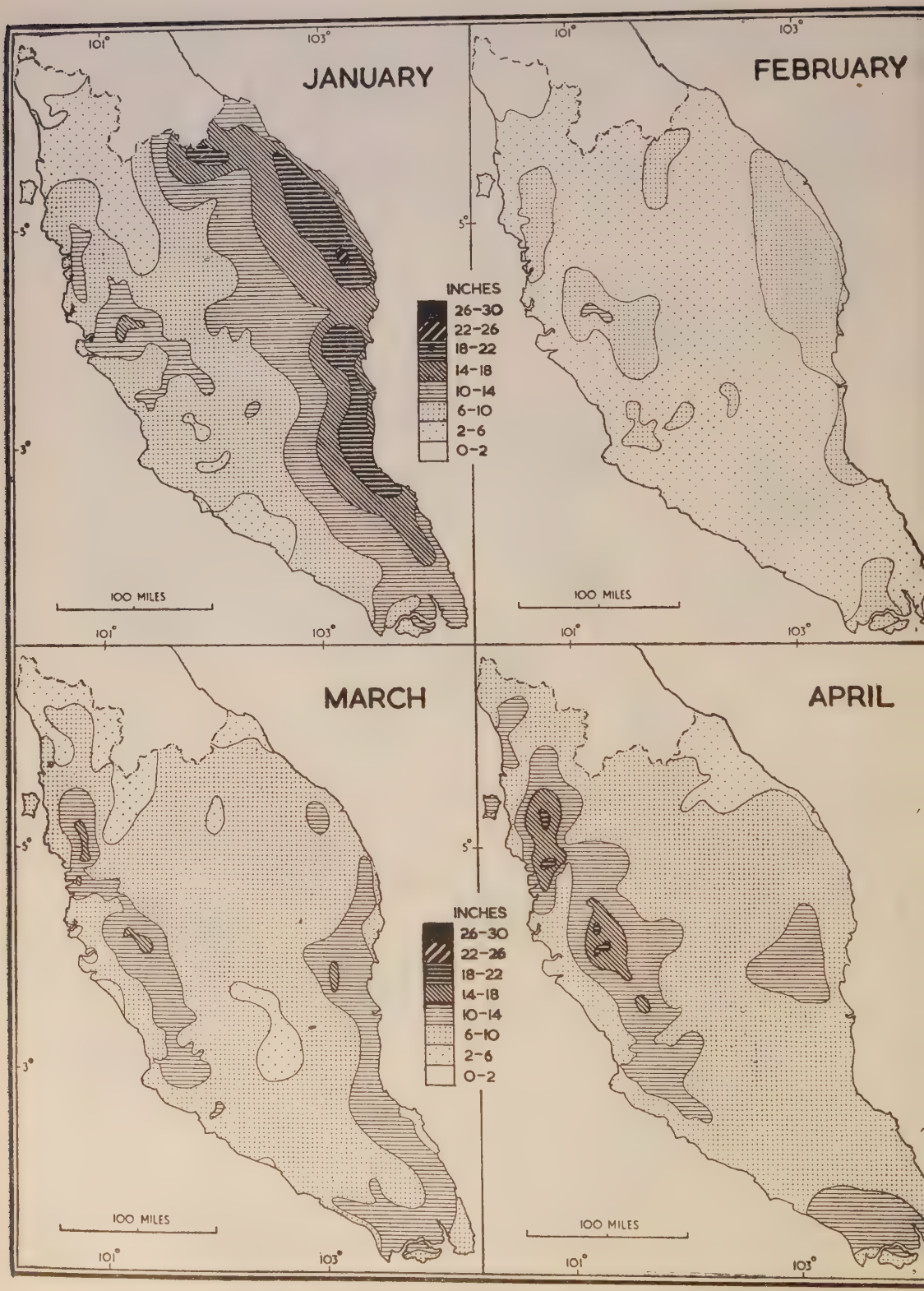

Fig. 6. Mean Monthly Rainfall, January to April.

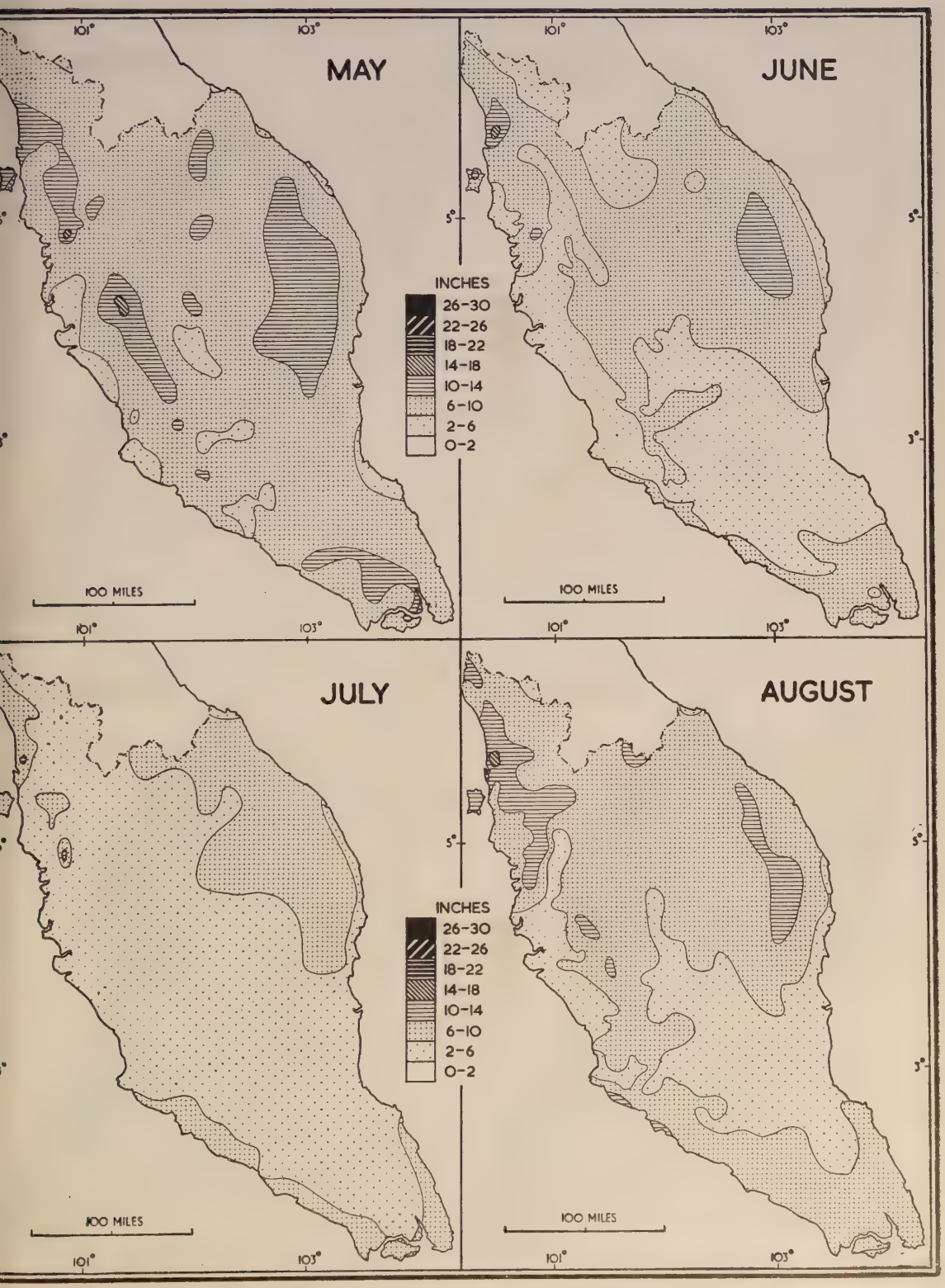

Fig. 7. Mean Monthly Rainfall, May to August.

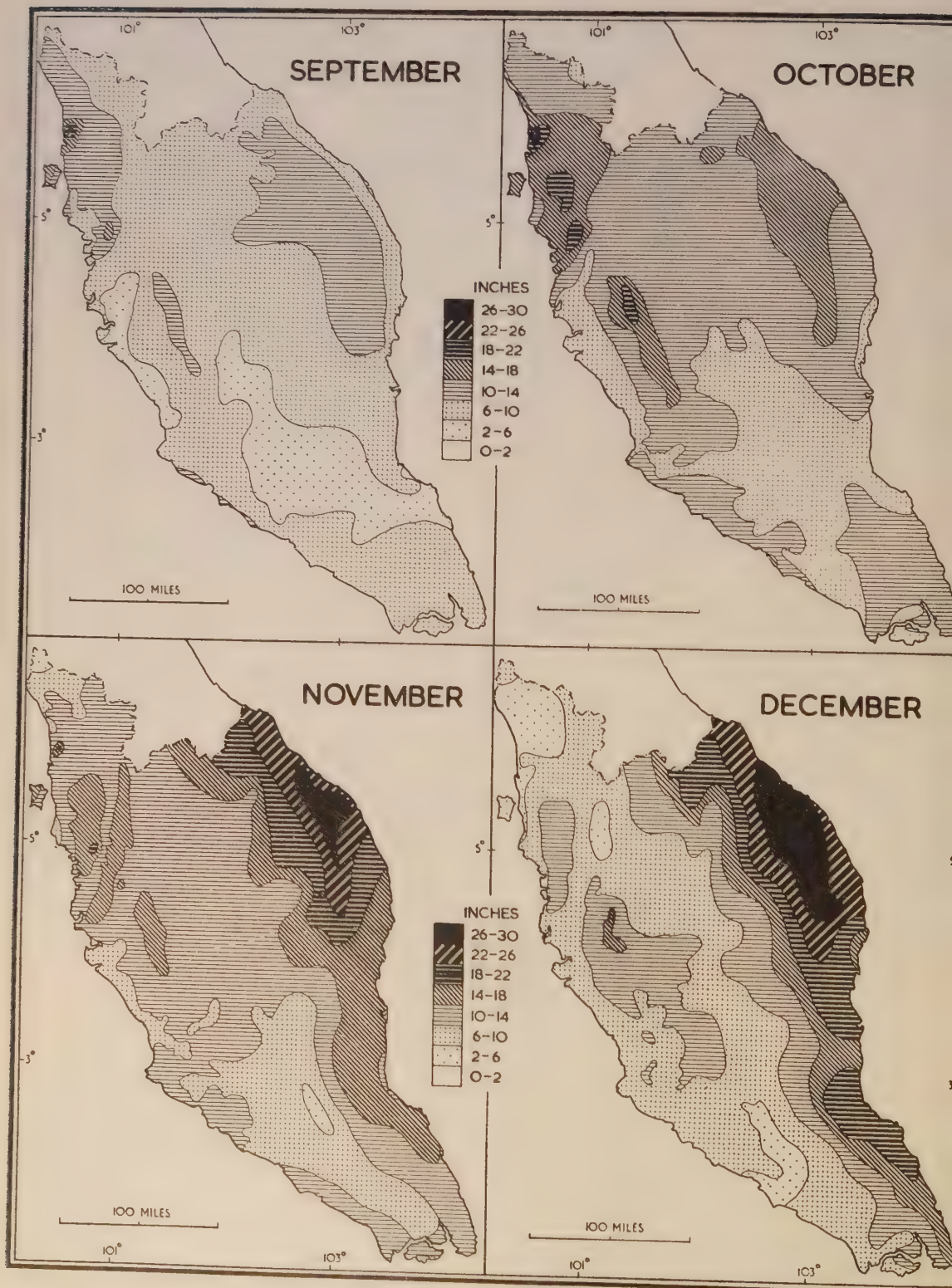

Fig. 8. Mean Monthly Rainfall, September to December.

or less. This is surprising in view of the strength of the north-east monsoon winds which are not remarkably less boisterous in February than in December and January.

Southern Perak is again the wettest region in western Malaya. Here the fall varies between 4 and 12 inches.

The driest area is in Perlis and north-west Kedah where the average amount is less than 2 inches. February is the driest month of the year for most stations north of Latitude 5°N. For the country as a whole, the total amount of rainfall received in February is less than half the total for December.

March. During this month the rainfall increases at most stations throughout the country. Two narrow wet belts appear; one along the east coast in Johore, Pahang and southern Trengganu; the other west of the mountains in Selangor, Perak and Province Wellesley. In both these belts the amount of rainfall ranges between 10 and 14 inches. In most other parts of Malaya the total for the month varies between 6 and 10 inches.

April is a transitional month between monsoons, when winds are light and variable in direction, or calm conditions may persist for 30 to 40 per cent of the days of the month. Surface heating under these conditions increases the instability of the atmosphere resulting in frequent heavy local showers in many parts. The month is one of a maximum of rainfall at most stations in western and central Malaya, but on the east it is a month of relatively low rainfall. At some stations on the east coast it is actually the driest month of the year, as at Kota Bharu and Mersing.

The wettest part of Malaya is found between the west coast and the Main Range and extends from Negri Sembilan in the south to central Kedah in the north. Here the monthly total varies between 10 and 20 inches. The axis of this wet belt runs along the western foothills of the mountains where a monthly fall of 16 inches is frequent, whereas at the summit of the Main Range the total seldom exceeds 12 inches.

The Kelantan Plain and the north-east coast of Trengganu are the driest parts of Malaya with only 3 to 6 inches for the month.

May. The April maximum in western and central Malaya is followed by a general decrease in May. On the east in Kelantan and Trengganu, however, a slight increase is recorded. Very few stations in the country have less than 4 inches or more than 13 inches.

Although the south-west monsoon prevails over northern Malaya from May until September, there is no pronounced wet belt in western Malaya during these months, certainly nothing comparable with the wet belt in eastern Malaya during the north-east monsoon. This may be due to the sheltering effect of the mountains of Sumatra which rob the south-west monsoon of much of its moisture.

June. The decrease noticed in May continues throughout June in all parts of Malaya. The wettest areas during this month are found over the highlands of Trengganu and small areas surrounding Kedah Peak and Maxwell's Hill. Elsewhere the month's total rainfall is rarely more than 10 inches or less than 3 inches. In north-west Malaya, June and July are the months with a high minimum of rainfall; January or February being the low minimum months.

July is the driest month of the year for most of the country. Less than half as much rain falls in this month as in December. The only areas with a monthly

fall of more than 6 inches are; (1) a narrow coastal strip from Port Swettenham to Singapore on the west, and a similar stretch from Mersing to Singapore on the east; (2) north-east Malaya, including northern Kelantan and most of Trengganu; (3) small patches in Penang, western Perak and the coastal plain of Kedah and Perlis. Though the south-west monsoon is now well established and a heavier fall of rain would be expected in the west, in fact eastern Malaya is as wet as, if not wetter than, the west. The western lowlands from the latitude of Penang southwards to Kuala Lumpur receive only 2 to 4 inches during this month.

August. From August until November the monthly rainfall at most stations shows a steady increase. The increase is particularly pronounced in north-west Malaya, where a maximum is reached in October.

During the south-west monsoon northern Malaya is, in general, wetter than the south.

September. The rainfall at most stations in the country shows an increase in September over that for August, especially in northern Malaya. Stations in southern Malaya show only a slight rise compared with the figures for the previous month.

October is the transitional month between the south-west and north-east monsoons. It is the wettest month of the year in north-west Malaya (north of Latitude 5°N), and is everywhere wetter than September. Very few stations have less than 7 inches; most places in northern Malaya have more than 12 inches. In October, as in April, the west is generally wetter than the east. But this situation soon changes with the advent of the north-east monsoon in the next month.

November. The onset of the north-east monsoon in November brings heavy rains to eastern Malaya. The heaviest fall occurs in the north-east where the foothills of the eastern highlands in Trengganu receive from 20 to 28 inches, and the Kelantan plain 18 to 24 inches.

In north-west Malaya there is a distinct decrease compared with October. In Perlis and north-west Kedah most places receive less than 10 inches. In western Malaya, as a whole, the tendency is for the monthly total to decrease slowly after October. But in central Malaya November is, in many places, the wettest month of the year, with a slight superiority over the rainfall totals of October and December.

December is the month of heaviest rainfall throughout the entire length of the east coast. The highest monthly falls for all Malaya occur here at this time. Kota Bharu has 26 inches, Kuantan 20·5 inches, Pekan 26 inches and Mersing 20 inches.

In central and western Malaya, December is drier than November. At many stations in north-west Malaya the rainfall in this month may be only fifty per cent of the total for November. The difference, however, between the totals for November and December decreases from north to south.

According to the average annual total more rain falls in Malaya in December than in any other month of the year, although it may be that in some years the total for November exceeds that for December. In some parts there is a remarkable decrease in the total monthly rainfall from December to January, particularly in north-eastern Malaya.

The high rainfall in December is associated with the onset of the north-east monsoon. Air from the north-east replaces the air from the south-west, forming an air-stream boundary which moves slowly from north-east to south-west. The

boundary crosses Malaya during November and December, and is accompanied by considerable falls of boundary rain. Also, uplift within the north-easterly air-stream, as it encounters the land barrier, results in a heavy fall of orographic rain.

RAINFALL REGIONS

Five types of rainfall distribution may be distinguished in Malaya, four in the central and western parts of the country and one on the east (Fig. 5 inset).

(1) *North-west.* This region includes the area north of approximately 5°N latitude, and west of the mountains. Its rainfall regime includes two maxima and two minima in a year. The maxima coincide with the transitional seasons—a low maximum occurring in April-May, and a high maximum in October. The minima occur during the monsoons—a low minimum in February and a high minimum in June. The rainfall in January and February, when the north-east monsoon is well established, may be exceptionally low compared with that in other parts of Malaya. At Kangar, for example, the average fall in January and February is only 1.7 inches per month, and in 1940 there was no rain at all during either month. The low rainfall in December, January and February distinguishes the north-west from the remainder of the country, which, in general, has a relatively high rainfall during these months.

The annual rainfall varies considerably throughout the north-west region. Perlis and northern Kedah receive a fall of between 65 and 90 inches, whilst the three areas of higher land—Kedah Peak, Penang and Kulim (southern Kedah)—form the cores of localities with totals ranging from 110 to 140 inches or more.

The distribution at Alor Star may be taken as typical of stations north of latitude 5°N, or thereabouts. At this station 36 per cent of the total annual rainfall is received during the north-east monsoon (November to April), 41 per cent during the south-west monsoon (June to September) and 23 per cent during the transitional months (April/May and October).

The relatively high percentage of rainfall received during the south-west monsoon may be due, in part, to the diminished sheltering effects of the mountains of northern Sumatra compared with those further south. The May maximum is probably associated with the crossing of the Southern Air-Stream Boundary over this part of Malaya during that month, thereby supplementing convectional showers with a certain amount of boundary rain.

(2) *West.* This region includes the western lowlands between the latitudes of 5°N and 2°40N (approximate), and the interior of the country from the Thai border to about latitude 3°N. The distribution, as in the north-west region, shows two maxima and two minima in a year. The maxima occur during the transitional seasons of April and October/November. The October/November maximum is usually the larger. July is the driest month and February the second driest. The months during which the maxima and minima occur are apt to vary to some extent from place to place, and from year to year at any one place. Due to the sheltering effect of the mountains of Sumatra and Eastern Malaya the intensities of rainfall during the monsoons are not so great as those resulting from shower activity, especially the showers of the transitional periods.

The north-east monsoon brings more rain than the south-west monsoon, and dry spells of the length frequently experienced in the north-west region are rare. It is exceptional for any station in this region to experience a dry spell lasting for as long as a month. The rainfall is also more evenly distributed throughout the year than in the north-west and east regions.

The distribution of the annual rainfall in this region is characterised by a wet belt, running from north-west to south-east, pivoted on the Kampar-Tapah district. Within this elongated belt the annual fall ranges from 110 to 140 inches, and around it the annual total decreases to 75 inches in the Perak valley to the north, along the coast to the west and in the Temerloh District of Pahang to the south-east. North-eastwards the yearly rainfall remains at just over 100 inches.

Taking Sitiawan as a representative station, it is observed that 50 per cent of the annual rainfall occurs during the north-east monsoon (November to March), compared with only 29 per cent during the south-west monsoon (May to September), and 21 per cent during the transitional seasons (April and October).

(3) *Port Dickson-Muar Coast.* There is a narrow coastal belt, probably not more than about 10 or 15 miles wide, extending roughly from Port Dickson to Muar, which has a rainfall regime remarkably different in certain respects from that of any other part of the country. In this small region the tendency is for there to be only one maximum and one minimum in the year. The heaviest monthly fall, of about 10 inches, occurs in the transitional month of October, whilst the months of January and February are relatively dry, the average for February being 3 inches. Unlike other rainfall regions of western Malaya, April does not normally show a marked maximum, nor July a noticeable minimum. Some stations may, at times, show a double maximum and minimum, but the secondary maximum and minimum are insignificant. Only 36 per cent of the annual precipitation is received during the north-east monsoon, whilst 45 per cent falls during the south-west monsoon and 19 per cent in the transitional months.

The relatively high rainfall during the south-west monsoon may be due, in part, to the landward movement of heavy showers associated with line-squalls or 'Sumatras' which sometimes form in the Straits of Malacca during the night. Such showers are particularly frequent along the west coast between Singapore and Port Swettenham.[1] Another reason for the unusually high rainfall during the south-west monsoon is the presence over this part of the west coast of the Southern Air-Stream Boundary during the months of June, July and August, thereby supplementing convectional rain with boundary rain.

The annual rainfall for the region as a whole is about 90 inches, much of which comes in the form of heavy early morning showers.

(4) *South-west.* The south-west region includes south-east Negri Sembilan, south-west Pahang and western Johore, but excludes the Port Dickson-Muar coast.

A prominent feature of the rainfall regime in this region is its relatively even distribution throughout the year, more so than in any other part of Malaya, except Singapore. At very few south-west stations does any month receive more than 10 or less than 5 inches. The north-east monsoon is slightly wetter than the south-west monsoon, and the proportion of the rainfall received during the transitional seasons is here less than in other regions except the east. A little more than 80 per cent of the annual fall occurs during the monsoons, and less than 20 per cent during the transitional months. Although the intermonsoonal months of April and October/November are, at most places in this region, the wettest months, their totals do not stand out as prominently as in the north-west and west regions. Minima occur in February and July, and, as in the north-west region, the February minimum is often slightly lower than that for July.

1. Watts, op. cit., pp. 70-1 and 156-77. The effects of line-squalls and 'Sumatras' will be discussed in Part II of this study.

The annual amount of rainfall for the region as a whole is less than in any other region, except the Port Dickson-Muar coast. It ranges from less than 70 inches in south-west Pahang to between 100 and 110 inches in south-west Johore.

(5) *East.* The pattern of monthly rainfall distribution in eastern Malaya differs considerably from that in the other regions. Whilst the monthly totals, at some places on the east, show two or even three maxima and minima, the tendency is for there to be one primary maximum and one primary minimum, the others being relatively insignificant (see Fig. 5).

In Kelantan and Trengganu, in the north, the maximum fall occurs in November and December at the beginning of the north-east monsoon. Thus at Kota Bharu no less than 42 per cent of the annual rainfall is received during these two months. December is usually the wetter of the two.

To the south, along the coasts of Pahang and Johore, the maximum occurs a little later—in December and January, and at inland stations in Johore, such as Kota Tinggi and Johore Bahru, January is the wettest month of the year.

The driest month varies according to the locality and from year to year, it may be April, June or July.

Rainfall in eastern Malaya is less evenly distributed through the year than in any other region. At Kota Bharu for example, the fall in April is 4.58 inches compared with 26.01 inches in December. At Pekan a minimum of 4.56 inches occurs in July whilst the maximum is 25.95 in December. The very uneven distribution, however, disappears in southern Johore and Singapore. Although Singapore is included in the east coast type of rainfall regime it is really transitional between the east and south-west regions. The range of the monthly mean values at Singapore is only 3.87 inches, that is from 6.59 inches in July to 10.46 inches in December. Most of Singapore's rain comes in the form of showers. Due to its low relief the orographic effect is small.

For the eastern region, in general, approximately 60 per cent of the annual rainfall occurs during the north-east monsoon (November to March), 26 per cent during the south-west monsoon (May to September), and only 14 per cent during the two transitional months (April and October).

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THE COOK ISLANDS

Land Use in an Island Group of the South-west Pacific

By W. B. JOHNSTON

THE IMPACT of Western culture and modern commerce upon the island peoples of the Pacific has resulted in fundamental changes in the native way of life, evidence of which is often visible in the present landscape. An earlier article illustrated this by an analysis of house types and settlement forms in the Cook Islands.[1] A study of land-use patterns shows the extent to which crops grown for sale now occupy large areas, and the way in which the traditional food-crops are being replaced by those that are easier to grow and less time-consuming.

The production of crops for sale has led to entanglements over land tenure, the solution of which is not yet fully apparent. At the same time the islander is frequently at a loss to understand the vagaries of overseas markets and is easily discouraged from careful crop management when much of his export crop perishes because of lack of shipping space and storage facilities These are some of the regional problems that are widely recognised throughout the Pacific Island area but they vary considerably in detail and importance not only from group to group but also from island to island.[2]

The Cook Islands lie near the southern margin of the vast, triangular, island-studded and oceanic area of Polynesia and they are formally a part of the Dominion of New Zealand (Fig. 1). The fifteen islands of this insular, tropical 'province' are widely scattered over an extensive area of ocean. The seven islands of the Northern Group are all coral atolls or 'low' islands; those of the Southern Group are primarily volcanic or 'high' islands and include the major units of land area, population and agricultural production.[3]

The centre of the Administration, the greatest concentration of people, and the focus of economic activity is Rarotonga, a high island in the Southern Group (Plate I, top left). It is elliptical in shape, approximately twenty miles in circumference and has an area of 16,500 acres. The population totals about 7,500, almost 300 per square mile. Of all the islands in the Group, Rarotonga has received the fullest impact of Western contact. The interaction of native and alien cultures has resulted in conditions that have been described as giving 'the impression of social disintegration'.[4]

This study is concerned specifically with land-use patterns in one tribal District of Rarotonga, that of Arorangi. This District is probably the most intensively cultivated part of the island, and it illustrates many of the features

1. W.B. Johnston, 'The Cook Islands: Settlement in an Island Group of the South-West Pacific', *Malayan Journal of Tropical Geography,* Vol. 5, 1955, pp. 1-11.
2. H.S. McKee, 'Some Food Problems in the Pacific Islands', *South Pacific Commission Technical Paper,* No. 106, 1957; V.D. Stace, 'The Pacific Islander in Modern Commerce', ibid., No. 54, 1954; H. Belshaw and V.D. Stace, *A Programme for Economic Development in the Cook Islands* (Wellington, New Zealand, n.d.).
3. For a general account of the geography of the Cook Islands see W.B. Johnston, 'Land, People, and Progress in the Cook Islands', *Economic Geography,* Vol. 29, 1953, pp. 107-24.
4. Belshaw and Stace, op. cit., p. 1.

of land use in the southern islands in particular and, to a lesser extent, in the northern atolls.

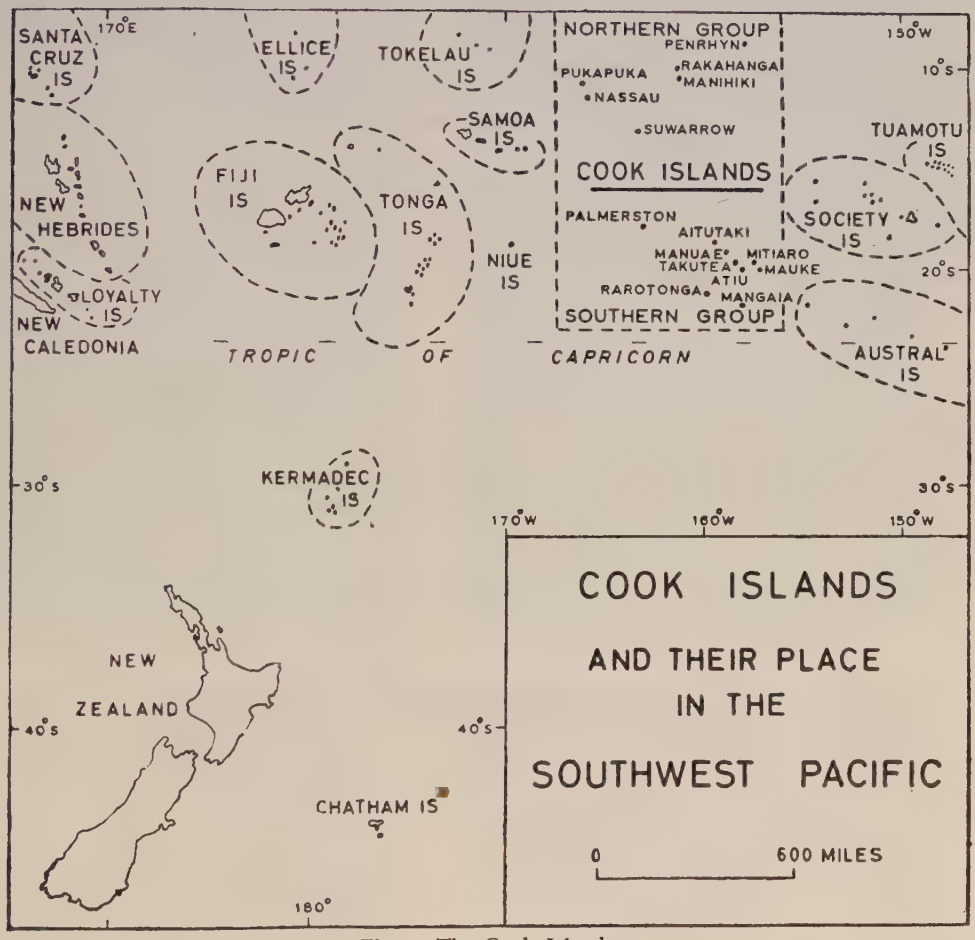


Fig. 1. The Cook Islands.

DIVERSE PHYSIQUE

The Arorangi District forms the western segment of the island and occupies slightly less than one-fifth of the total land area (Fig. 2). With a coastline of approximately five miles, it extends inland for one mile at the deepest point while the narrowest section is less than half a mile wide. Stretching from the fringing coral reef to the mountain core, the District provides a cross-section of landforms, soils and vegetation.[1] On this small island there is no marked wet or dry side and on the coastal lowlands there are no significant climatic contrasts.

Proceeding inland, a fivefold division of surface configuration may be recognised. These are: the coral reef and shallow lagoon; the low makatea; the depression; the terraces and fans; and the volcanic mountainous interior (Fig. 3).

1. P. Marshall, 'Geology of Rarotonga and Atiu', *Bernice P. Bishop Museum Bulletin*, No. 72, 1930; L.I. Grange and J.P. Fox, 'Soils of the Lower Cook Group', *D.S.I.R.* (*of New Zealand*) *Soil Bureau Bulletin* (*New Series*), No. 8, 1953.

The lithothamnium ridge forms the upturned edge of the fringing coral reef which marks the seaward limit of the shallow and narrow lagoon. There are no passages through the reef large enough to provide entrance for inter-island trading vessels. Even if entrance was possible, the shallow depth of the lagoon would preclude its use as a sheltered waterway. The lagoon averages from five to seven feet in depth and is only 200 to 300 yards wide. Sheltered but shallow and narrow, the lagoon has no pretensions as even a minor 'inland' waterway.

The low makatea forms a continuous coastal belt. It has the character of a flat strand, ten to fifteen feet high, and extends about 100 yards inland. The soils of this raised coral reef are skeletal, consisting of little more than coral sand and fragments stained with humus. Within the makatea are areas containing a high proportion of hard lumps of dead coral which makes the tillage of the soil extremely difficult.

Inland from the low makatea the surface descends almost to sea level in the form of a marked depression. This low-lying area, never more than 200 to 300 yards in width, is variable in character (Plate I, top right). The depression was, apparently, the site of a former lagoon now filled in with alluvium which, generally, is of a swampy nature. Two exceptions to these conditions are where the alluvium is well-drained, and where streams, in crossing the depression to reach the coast from the interior, have built natural levees. Where there is free drainage of the fine alluvium the depression is distinguished by soils of friable, dark-brown, clay

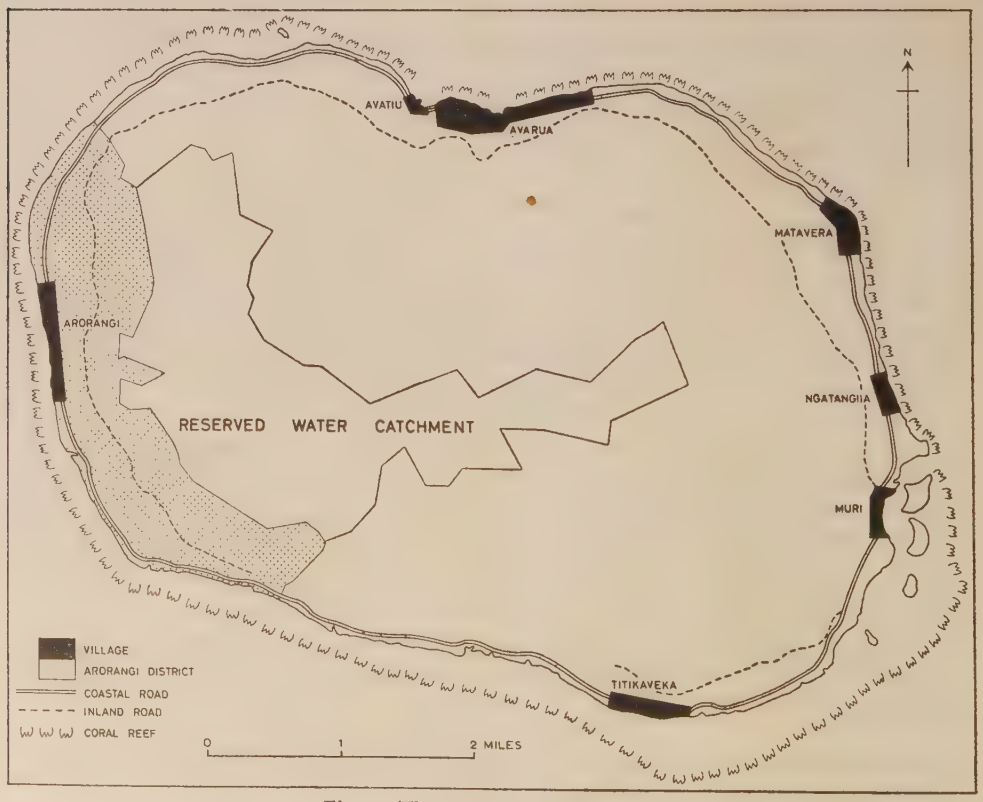


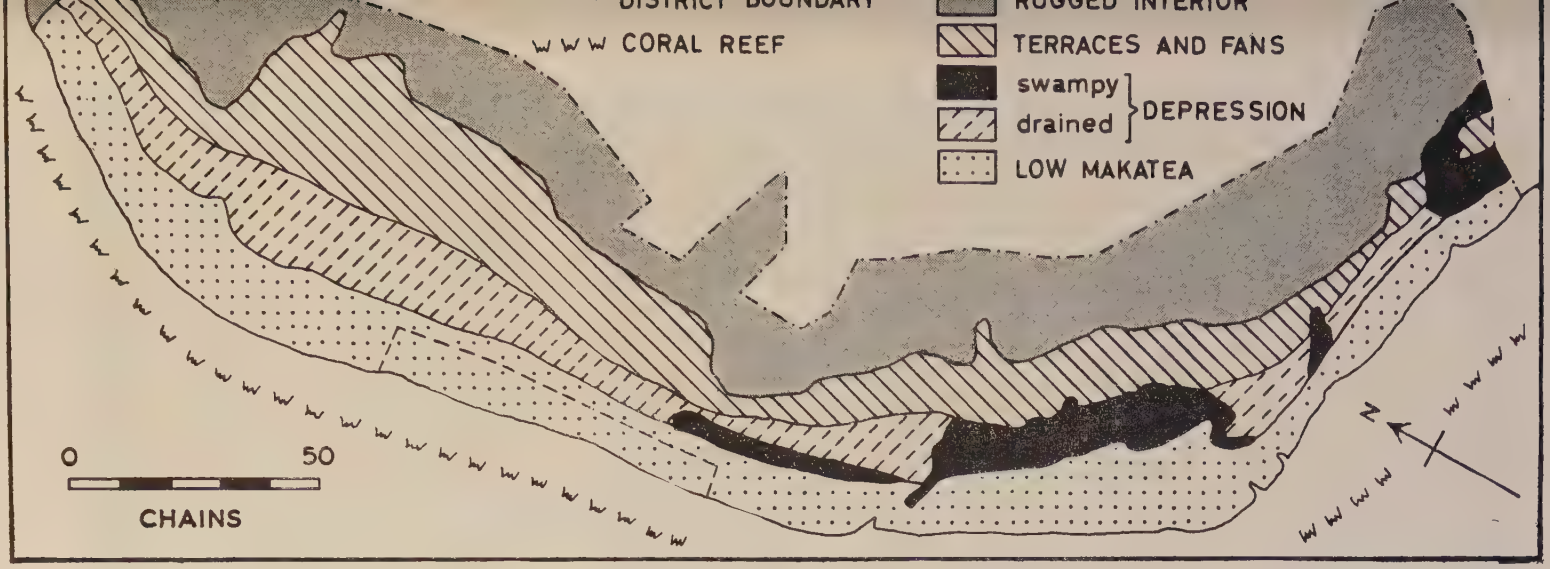
Fig. 2. The island of Rarotonga.

Plate I.

Top left: View from the reef near Avarua (Courtesy of National Publicity Studios). *Top right:* A part of the depression with a taro plot in the foreground and guava and hibiscus on the neglected areas. The line of coconut trees in the background marks the low makatea. *Bottom left:* Taro plots in the depression. In the foreground are new plantings with a protective layer of coconut palms. Behind are taro plots seven months old. Bananas line the embankments. *Bottom right:* Planting taro tarua on a terrace.

Plate II.

Top left: Kumaras beneath coconut trees on the terraces and fans. On the right, replanted coconuts are beginning to show above the weeds. *Top right*: Wild orange trees and weeds. *Bottom left*: Northern coastal lowland with cultivated orange plots. *Bottom right*: The non-agricultural interior of secondary scrub and forest. In the centre, frequent and purposeless burning has resulted in a dominating fern cover. Scattered wild orange trees occur in the valleys and along the slopes.



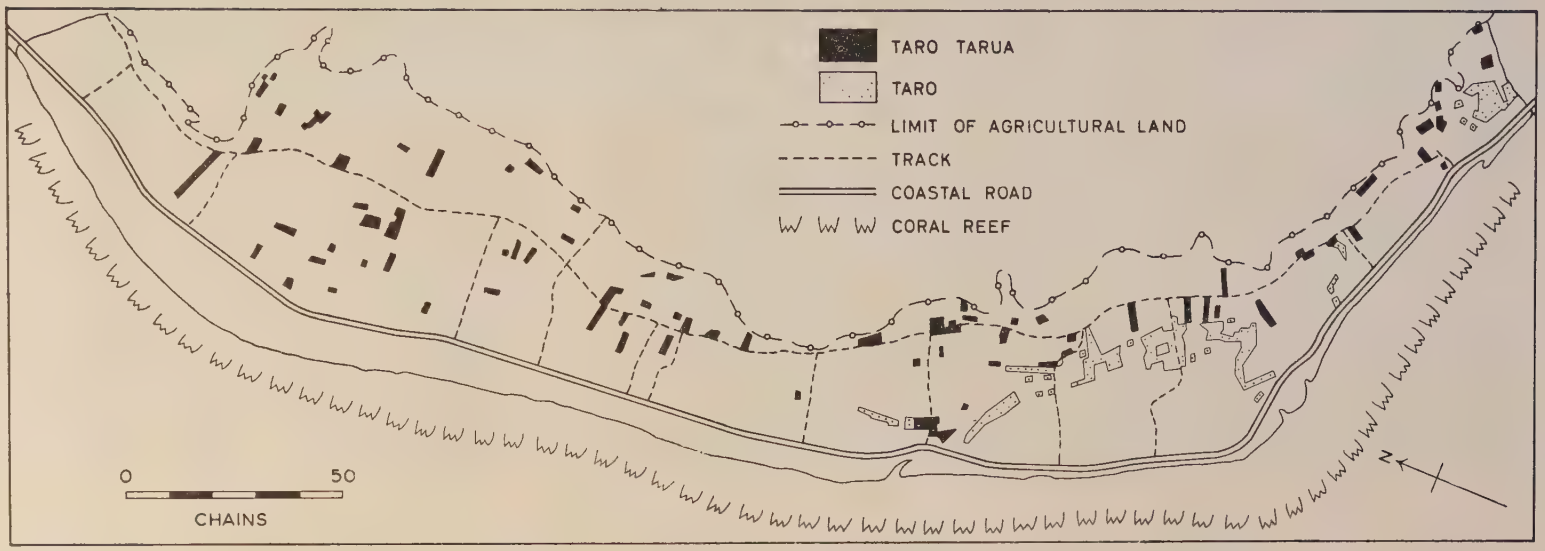


Fig. 3. The physical divisions of the Arorangi District. The site of the village is shown by a broken line.
Fig. 4. The distribution of Taro and Taro Tarua in the Arorangi District.

loams varying in depth from twenty to thirty-six inches. They are very fertile and are associated with one of the major agricultural areas. The other soil type of the depression is strikingly different and is developed in the swamp. It is largely man-made, the result of a long period of continuous taro cultivation. Areas which would normally be drained have been deliberately flooded, often by means of a network of irrigation channels, in order to supply a basic need of the hygrophytic taro. During periodic floods top-dressings of rich silt have been added, all of which have greatly assisted the maintenance of agricultural production. Under these conditions the clay loams have developed typical gley colours.

The terraces and fans are composed of fine and coarse basaltic material brought down from the rugged interior by numerous streams, and deposited to form a narrow inner zone, one-quarter to one-half of a mile wide. The elevation of the terraces is approximately twenty-five feet although the steeper fans, which have gradients of one in four or five, rise to fifty or seventy-five feet before reaching the hills. The soils, generally fertile, of friable structure and yellow-brown in colour, have been intensively cultivated to form another major agricultural area.

The mountainous interior is largely composed of extensive flows of basalt which have been deeply and finely dissected by vigorous stream erosion to give deep, steep-sided, narrow valleys and sharp razor-back ridges. The high elevation with peaks rising to over 2,000 feet, the mature dissection, and the wide areal extent combine to give a really mountainous aspect to most of the District and to the Island as a whole. The skyline is broken by sharp jagged peaks and crenellated ridges to produce the uneven outline that is typical of 'high' islands.

The tropical climate is characterised by an average annual mean temperature of 74°F., an average seasonal range of 8°F., and an average annual precipitation of 83.5 inches with no distinctly dry season. Well-distributed rainfall and high temperatures provide suitable climatic conditions for a wide range of plants and a vigorous growth of luxurious vegetation. Considerable importance must be attached to the intense nature of the precipitation. At least one fall of more than five inches in a day is likely in a year and falls of eight inches in twenty-four hours are not uncommon. Limited periods of gale-force winds—on an average of three days each year, and the possibility of hurricanes, are further hazards to agriculture. Although the Cook Islands lie within the hurricane belt such storms are infrequent over Rarotonga.

Few remnants of the original tropical rain forest have survived and, even in the interior, the larger forest members have been milled for building material and for boxwood. Where the land is not cultivated, secondary forest with the inevitable thick mesh of trees, lianas, ferns and bushes has taken control. On many spurs radiating from the main ranges, continued burning of the vegetative cover, and accelerated soil wash have resulted in the deterioration of the vegetation and soil to a condition under which almost a complete mat of low fern (*Gleichenia* or *Dicranopteris linearis*) is dominant.

AGRICULTURAL AND NON-AGRICULTURAL LAND

Two-thirds of the island of Rarotonga is agriculturally unused. The unproductive area corresponds broadly to the volcanic mountainous interior over most of which the dominant form of vegetation is secondary forest or fern.

During the pre-missionary era, when the interior was of greater significance, the numerous valleys were commonly irrigated for taro cultivation. Relict forms of the period remain in one or two inaccessible places far up the valleys. Until

a decade ago the gentler slopes, especially on the margins of the interior highlands, were major banana-producing areas. The cultivations were shifted regularly to minimize erosion and to permit a period for resuscitation of the soil. With the extinction of the banana export trade during the late nineteen-thirties and early years of the 1939-45 war, when shipping was short, the slopes have been surrendered to scrub and weeds, especially hibiscus and guava, which rapidly assumed control. However, during the last few years a rapid increase in banana growing has been brought about by financial inducements whereby the full price is paid for any bananas of suitable quality for export that are delivered for shipment, whether or not shipping space is available. The story of the banana trade illustrates the difficulties of producing perishable crops for export to distant markets when transport is uncertain.

The interior still furnishes small quantities of timber and many varieties of wild fruits and berries. In addition it is the catchment area for the numerous permanent streams which radiate from the central part of the island. Moreover with the reticulated water supply dependent on inland reservoirs, the preservation of the vegetative cover of the interior assumes paramount importance. This general principle is of special significance to an island where the tropical agents of erosion can rapidly ruin the exposed land.[1] Consequently a large portion of the interior is preserved as a water catchment and is not subdivided for family lands. To assist in the problem of conservation of soil and water, experiments in the re-afforestation of burnt-over areas are being carried out by the Department of Agriculture. One of the most promising experiments is with *Albizzia falcata,* a tree of rapid growth habit and with possibilities as a future source of boxwood,[2] an important consideration in view of the high cost of imported shooks for fruit cases. So far, however, the replanting scheme has been very limited on Rarotonga.

The agricultural land includes the physical divisions of terraces and fans, depression and low makatea. It is peripheral, narrow and low-lying. It is the site of all settlements and the route for all roads and important tracks. A coastal road forms the main routeway, and an inland track—*ara metua,* the ancient road of Toi—marks roughly the inner edge of the depression. To complete the network, these two routeways—one historic and the other modern—are connected by numerous tracks suitable for wagon traffic, horses and jeeps.

BASIC FOOD CROPS

Although the traditional subsistence economy no longer exists, many of the individual crops and other features remain. The essential distinguishing item of subsistence land use is the cultivation of food-crops primarily for domestic consumption, the cultivation being on family lands which are held on a communal basis without any legal individual ownership. An important and convenient division is made between 'wet' land and 'dry' land field crops.

The cultivation of wet land field crops is confined to the many varieties of taro (*Colocasia* species)[3] and is areally limited to the swamp zone (Fig. 4).

1. C. Marshall, 'Forestry Problems of the South Pacific', *Agricultural Journal* (Fiji), Vol. 4, 1949, pp. 121-6.
2. R.G. Thornby, 'Afforestation in the Cook Islands' *South Pacific Commission Quarterly Bulletin,* Vol. 4, 1954, pp. 15-16.
3. In strict botanical terms taros are tuber-producing *Araceae* belonging to the genus *Colocasia.* In popular terms other plants of the same family are also called taros. *Taro tarua* of the Cook Islands is *Xanthosoma sp.* See E. Massal and J. Barrau, 'Food Plants of the South Sea Islands', *South Pacific Commission Technical Paper,* No. 94, 1956, pp. 6-11.

Irrigation is necessary for taro since it requires a plentiful supply of moisture. The taro plots are small (50 to 100 square feet) and are separated from one another by built-up mounds of earth which impound the water. Foot tracks follow the tops of the mounds and strings of banana plants, hibiscus and guava help to demarcate their line (Plate I, bottom left).

Taro now occupies only a small percentage of the available area that is physically suitable. Whereas the crop was formerly the main staple in the diet, a century of European contact has resulted in an accelerating decline of its importance in the face of competition through the introduction of other crops and imported foodstuffs, especially tinned meats, biscuits and similar store goods. The local cultivator's reliance upon produce from his land for the basic necessities to feed himself or his family is rapidly being replaced by a dependence upon imported foodstuffs. In common with these changes is a growing dislike for the regular and meticulous care required for the successful growth of taro.

The cultivation of the crop still follows methods that are traditional in many islands of the Pacific region.[1] The soil of the irrigated plot is turned over and the taro propagated by hand planting of the upper section of the corm. Coconut fronds are laid over the soil and serve three main purposes: (1) to stifle the rapid growth of weeds; (2) to provide additional humus for the soil from the decaying fronds; and (3) to prevent excessive evaporation (Plate I, bottom left). Taro takes about seven months to mature and none of the plant is wasted. The root is cooked in various ways and is commonly eaten with coconut cream. The leaves are boiled and used in a manner very much like European cabbage. The remaining portion of the corm is replanted.

The unused areas of the swamp are infested with numerous weeds, particularly guava and hibiscus both of which are mature indicating a relatively long period of disuse (Fig. 8).[2] Even the taro plots are often left unweeded. In addition the disused areas of the swamp greatly aggravate the mosquito problem, and therefore filariasis, in providing breeding places and extensive harbourage frequently close to the dwellings.[3]

The distribution of taro plots shows a marked concentration in two areas (Fig. 4). The first of these is at the southern margins of the District, while the second and largest area forms a discontinuous zone immediately south of the village. Beyond the two areas there are only a few small and scattered plots. The total area devoted to taro and the production from it are small in proportion to the demands of the District's population which totals over 1,000 persons. Moreover the location of the taro grounds at some distance from the village entails extra travelling time. However, these areas are physically more favourable than those in the immediate vicinity of the village, particularly in relation to available water from the streams.

The dry land field crops include those grown without irrigation and primarily for family consumption. Among the various crops are *taro tarua, kumara, maniota,* beans, bananas, corn and pineapple, but only the more important of these are

1. See for instance R.E. Murphy, 'The Economic Geography of a Micronesian Atoll', *Annals of the Association of American Geographers,* Vol. 40, 1950, pp. 58-83.
2. The field mapping upon which this article is based was carried out in the summer of 1950-51: hence care must be taken in the interpretation, particularly in regard to short-term crops. Where necessary allowance has been made for this in the text.
3. G.H. Satchell, 'On the Possibility of Controlling Filariasis in Rarotonga', Appendix A to *Report of (Medical) Research Expedition to the Cook Islands, 1949-50,* University of Otago, New Zealand (cyclostyled).

considered separately here. They are *taro tarua* (dry taro), *kumara* (sweet potato) and *maniota* (cassava or manioc). Coconut palms form a very significant item in subsistence land use, and will be considered in detail later.

Taro tarua, (*Xanthosoma* sp.), the unirrigated counterpart of taro, is widely distributed throughout the well-drained fertile soils of the depression and the clay loams of the terraces and fans (Fig. 4). In the northern half of the District the two physical types of land are juxtaposed. South of the village the cultivations are primarily on the terraces and fans following the line of the *ara metua.* The calcareous soils of the makatea are generally avoided with the exception of one or two plots which are nourished by a greater accumulation of humus. The specific details of the pattern show no compactness or localization of individual plots comparable with that of the taro grounds.

The cultivation of *taro tarua* involves a relatively small amount of labour and care. To prepare the land for planting, a horse-drawn single furrow plough is frequently used. In the first furrow the upper sections of the corms are laid. The ploughing of the second furrow covers the corms in the first and opens the next for planting (Plate I, bottom right). Weeding is necessary during the early stages of growth, but once established little attention is given to the cultivations. Being a short-term crop, *taro tarua* is frequently grown following crops of tomatoes or after other food-crops such as *maniota.*

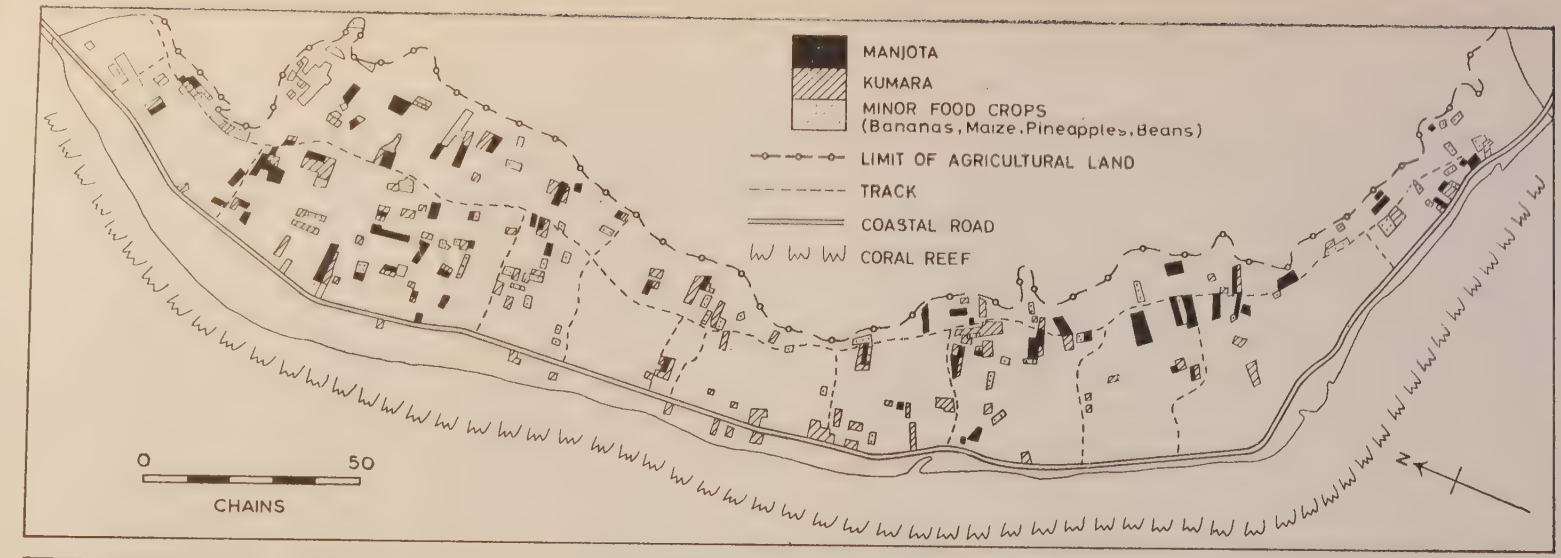
The two types of taro, wet and dry, display different features in methods of cultivation, labour demands, soil requirements and patterns of distribution. However, they have certain points in common. Both are essentially subsistence crops and both avoid the low makatea. Separately and together they occupy only a small percentage of the agricultural land despite their traditional importance as staples in the diet.

The sweet potato, known as *kumara* (*Ipomoea batatas*) in the Cook Islands, now figures more prominently in the diet than formerly. This is a reflection of the ease and rapidity of growth which allows more time for other activities. Moreover the *kumara* flourishes over a wide range of edaphic and climatic conditions, from the infertile sandy soils of the coast to the fertile clay loams of the interior valleys. Although the plant does not grow freely on the swampy soils of the depression it is nevertheless a tolerant plant as witnessed by its wide distribution (Fig. 5).

Certain features in the distribution pattern stand out clearly. Towards the south there are two zones—one related to the terraces and fans, the other to the makatea—with the swamp separating them. In the north, however, *kumara* spreads over the makatea and the depression (where well-drained), as well as the terraces and fans.

Kumara needs only a small amount of attention yet produces an abundant harvest of high food value. A short-term crop, it is readily replanted by means of stem cuttings. It matures, variously, in four to eight months; thus *kumara* is frequently planted after other crops have been taken from the plot.

Maniota (*Manihot* sp.) is another root crop of increasing importance. It has particular value as a reserve food supply since the crop can be left in the ground for ten months or more without a reduction in the edible value. It is the poorest of the major staples as the swollen roots contain almost pure starch, but it is popular since it produces higher yields than other crops and can be grown on exhausted soils.



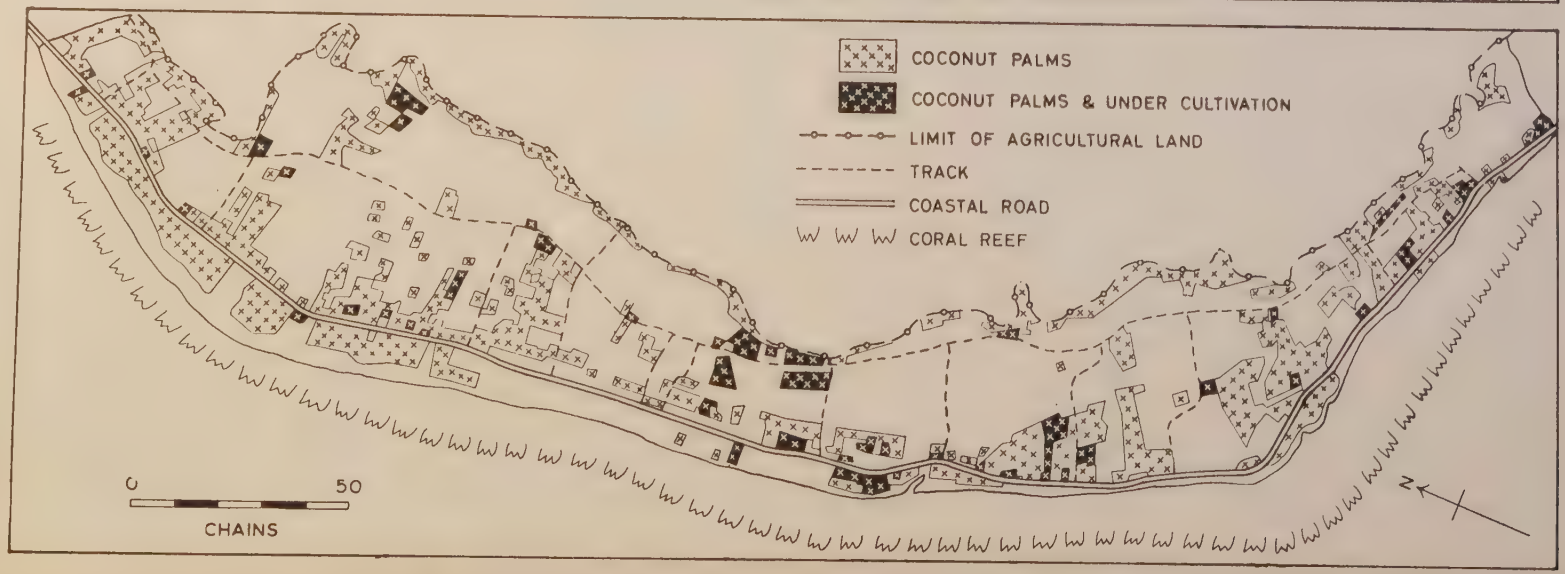


Fig. 5. The distribution of some food crops in the Arorangi District.
Fig. 6. The distribution of coconut palms in the Arorangi District.

The plant is grown from stem cuttings about six to eight inches long which are either planted into the soil or buried horizontally. Depending upon the variety planted, the crop requires from eight months to two years to mature, but the emphasis is on the quick yielding varieties. In area it ranks next to *kumara,* but in distribution it generally avoids both the swamp and the makatea. The main concentration is on the fertile soils of the terraces, fans and well-drained areas of the depression (Fig. 5). It can, however, grow on poor soils and, with the exception noted, is widespread. As it can grow on poor soils there is often a tendency towards soil exhaustion due to over-cropping. Despite this feature, and the unbalanced food value and low protein content, it continues to expand because it is very tolerant, easy to grow and gives high yields.

Beans, maize, pineapples and bananas are grouped together. All are grown in the Arorangi District essentially as family food-crops. The total area of cultivation is small and their importance is strictly limited. In distribution they usually avoid the swamp and the makatea (Fig. 5).

Finally, mention must be made of the tree crops which are basically associated with family needs. In the neighbourhood of virtually every dwelling there is found a wealth of bread-fruit, pawpaw and mango trees.

With the exception of taro, all the subsistence crops have a relatively wide distribution in the District with *kumara* and *maniota* the most tolerant of diverse physical conditions. The most restricted and localised crop is taro which is intimately associated with, but occupies only a portion of, the swamp. All the other crops are found on the terraces, fans, and on the well-drained soils of the depression particularly in the north, and in all areas they are frequently grown alongside one another. A final notable feature is the unrivalled importance of *kumara* as the single field crop which is grown extensively on the calcareous soils of the makatea.

In the pattern of food-crops other items are worthy of note. One of these is the small area of individual plots of one crop. Although this is by no means a universal feature, for instance some *kumara* cultivations cover more than a quarter of an acre, it is common to find *kumara, maniota* and *taro tarua* each planted in plots of five to fifteen square yards, while almost all the taro plots conform to these minute sizes. Allied to the tiny size of plots is the amazing variety of both field and tree crops within a small area. This is a general characteristic that is well described in terms of homestead gardens. A further illustration of the point is the frequency of inter-cultivation with as many as three or four crops alternating one with the other in an undivided plot. Equally representative of the subsistence land-use pattern is the cultivation of numerous crops under trees and, in particular, beneath the umbrella crowns of coconut palms (Plate II, top left).[1]

THE ROLE OF THE COCONUT PALM

The distribution of coconut palms is a striking feature of the land use. While they are found generally over all the area below 500 feet there is a distinct concentration on the calcareous soils of the makatea (Fig. 6). The concentration is related to the physical unsuitability of the makatea for most crops, and to the

1. It is necessary to emphasize that mapping of short-term crops is exact only for the period during which the survey was made. At another season, or at the same time in another year, the detailed location of most crops is likely to change, but the conclusions on general patterns and the areal extent of each crop have general validity.

palm's tolerance of saline and sandy soils, and the competition from other crops for the more fertile soils which cover the terraces, fans and the well-drained areas of the depression. The coconut palm does not usually flourish on clay soils and the one region in the Arorangi District where it does not grow freely is the swampy depression.

On first inspection the dominance of the coconut palm in the land-use pattern appears self-evident. Closer analysis shows that, despite the extensive planted area and its multiple uses, the palm no longer plays as important a role as formerly. Indeed in relation to the demand there is a serious shortage. Moreover few areas are scientifically managed; most palms are past maturity and only a very small amount of replanting is taking place. The general low density of palms per acre is directly related to the frequency of under-cultivation. With the exception of taro all other short-term crops are commonly grown beneath coconut palms. Figure 6 shows only the major areas where coconut palms and other crops are grown in association. Many areas mapped as solely under coconut palms had already, in the year of survey, produced a crop of tomatoes and were likely to be planted in *kumara* or other short-term food crops later on.

The coconut palm contributes little to the commercial aspect of land use in the Arorangi District. Only a small amount of the annual nut harvest is dried for copra. The average annual quantity of copra exported from the whole island of Rarotonga during 1953-57 inclusive was only fifty tons. The palm serves essentially subsistence needs which are of almost infinite variety, from material for baskets and mats to food for animals and humans. A major demand on the palm is for roofing material used in the native type of house. To meet the demand there is frequently an excessive defoliation of palms which reduces the nut yield. The decline in number and the increasing age of palms threaten further the supply which is already inadequate to meet the continuous and growing requirements.

The development of tomato cultivation since the nineteen-thirties is an important contributory factor in the shortage of palms. In order to make room for the new and popular crop large numbers of producing palms were felled. Likewise the recent replanting of citrus trees has resulted in further losses although, in this case, care has been taken to prevent unnecessary destruction.

In view of these considerations and the almost indispensable role of the coconut palm in the native life an immediate replanting scheme on a considerable scale is urgently needed.[1] The few small and unrelated attempts now being made are insignificant in relation to the magnitude of the problem. Yet they do serve to emphasize the urgency of the situation since the coconut palm is a long-term plant which requires from seven to ten years before reaching the bearing stage, and is not in its prime until the second decade of its life.

CASH CROPS

The distinguishing feature of commercial land use is the cultivation of crops primarily for sale. Although numerous crops enter this category, only two—tomatoes and oranges—are of major importance. However, three convenient divisions of cash cropping may be recognized; crops grown on a communal base; those on a plantation base; and those on an individual base. The system of land

1. The situation is clearly realised by the officers of the Department of Agriculture. The urgency has been emphasized by Belshaw and Stace: op. cit., pp. 93-100, who state that 'Cook Islands' copra has the unenviable reputation of being about the poorest in the Pacific'.

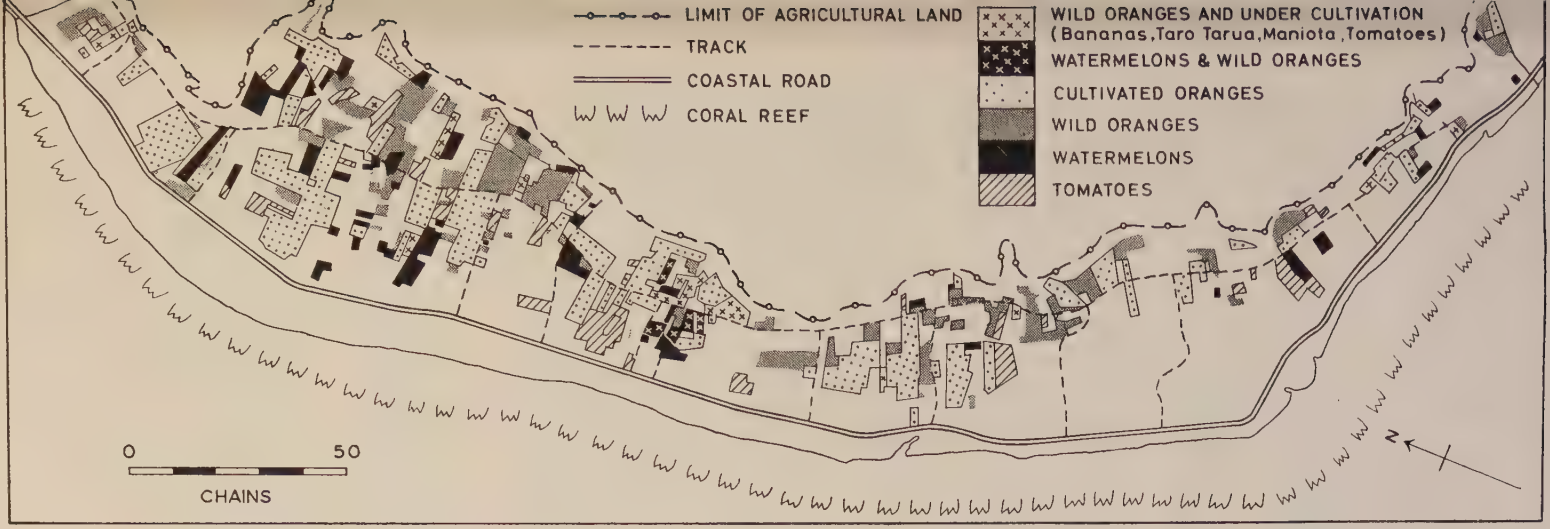


Fig. 7. The distribution of important cash crops in the Arorangi District.

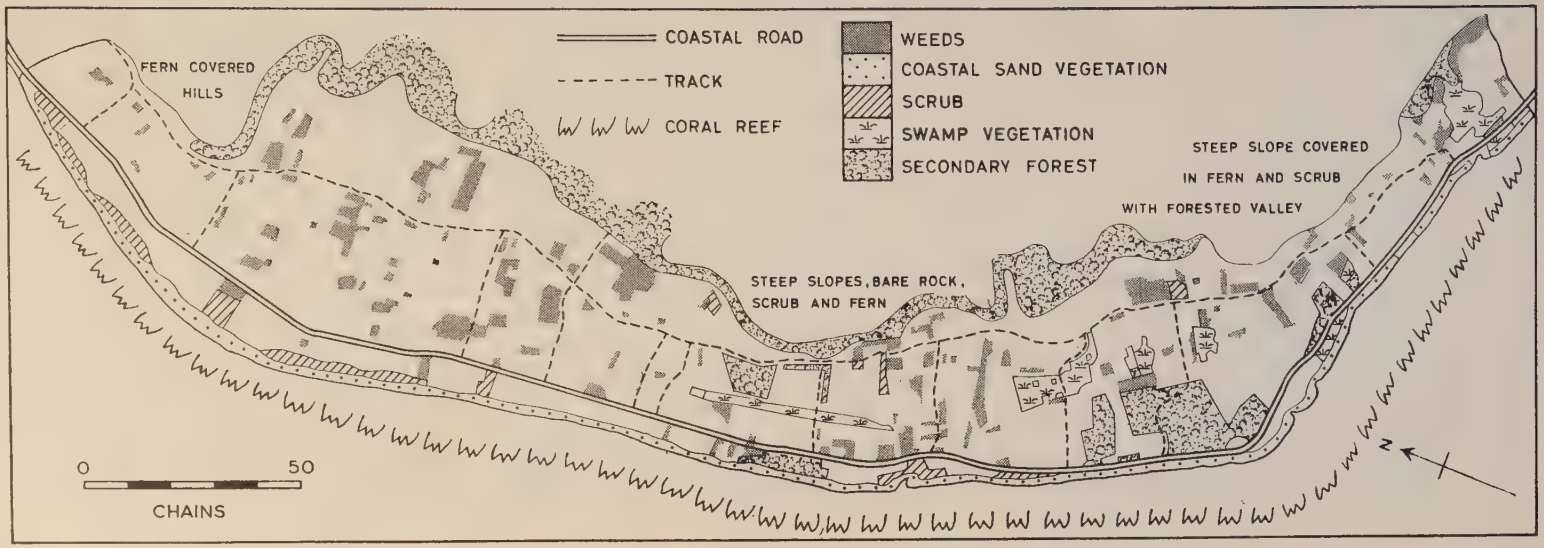


Fig. 8. The distribution of weeds, scrub and secondary forest in the Arorangi District.

tenure, and hence the organisation of production, provide the major criteria in differentiation.

Commercial crops grown on a communal base applies to production from land held within a communal system of land tenure, and is commonly associated with the sharing of profits. A usual distinction within this group is made between short-term and long-term crops.

The most significant short-term commercial crop is the tomato, the seasonal cultivation of which occupies a significant proportion of the total cultivated land (Fig. 7). The crop is grown from unselected seed kept by the growers from the previous year. The seed is sown in a box and, once established, is transplanted into the field to mature. Despite the lack of scientific management the plantings have, so far, been free from disease. However, the methods of cultivation do not encourage confidence and are unlikely to prevent disastrous results once disease encroaches on the cultivations.[1]

Tomato growing has undoubtedly attracted the imagination of the local cultivator. This is primarily in response to the high prices which are sometimes received when the harvest reaches the New Zealand market in good condition and at an opportune time. In view of the uncertainties of ocean transport, the growing and marketing of the crop is highly speculative in character. Failure of vessels to arrive at the exact time when the fruit is ready to be picked has all too frequently resulted in the loss of more than half the total harvest.

Yet the apparent disadvantages have not discouraged extensive seasonal plantings of the crop. Figue 7 is somewhat misleading since the tomato season was almost finished when the Arorangi District was surveyed, and a somewhat larger total area than that shown on the map is normally devoted to tomatoes. However, the distribution pattern remains valid and the concentration on the fertile soils of the terraces, fans and the well-drained parts of the depression is characteristic. Only in very minor cases have cultivations spread on to the makatea.

Following the tomato harvest the land is either allowed to revert to a weed fallow, or is cropped for family food, or is planted with water-melons. Water-melons find a favourable local market in the urban centre of Avarua where a weekly market is held. The crop forms the second important short-term commercial use of the land. It is characteristic of the northern portion of the District where the crop is commonly found in association with bananas and *taro tarua,* while under-cultivation of tree crops is equally distinctive (Fig. 7). As a source of ready cash during the summer off-season for other commercial crops it has local popularity.

The major long-term commercial crop on a communal base is citrus fruit (sweet orange). The orange trees grown on communal land have never been systematically planted or scientifically cultivated; they are now growing wild and dying of old age (Plate II, top right). Although fluctuations in the annual crop and an over-all decline in production are evident, they still contribute about half of the citrus exports.

Apart from the makatea and the swamp, the wild orange tree is found almost everywhere (Fig. 7). They are dispersed haphazardly amidst family plantings of *maniota, taro tarua, kumara* and bananas, and amongst the weed and scrub cover of temporarily abandoned land. They are also found in isolated hiding in the broken forest cover of the more inaccessible valleys and slopes. With their im-

1. G.S. Peren, 'Agriculture in Samoa, Cook Islands and Fiji', *Massey Agricultural College Bulletin* (New Zealand), No. 20, 1948.

portance in land use, the dispersed distribution and the frequency of under-cultivation, the wild orange tree provides a distinctive element not found in any other islands of the Pacific.[1].

On land leased to Europeans, or acquired by Europeans through marriage to natives, the cultivation of commercial crops on a plantation base is the typical form of land use. In general the state of cultivation is poor as such activities are usually secondary to trading or professional occupations. Indeed in some instances the character of land use is little different from that of the local cultivator. Coconut palms are a significant feature but a dense mat of undergrowth frequently makes the collection of fallen nuts difficult. Tomatoes are seasonally grown while citrus culture is practised by the more progressive owners. Budded orange trees are either nurtured in their own seedbeds and nurseries or purchased from the central nurseries of the Department of Agriculture. The state of the plantations underline their secondary importance. They are areally unimportant and produce limited quantities of crops.

The most significant form of commercial land use—the modern citrus industry—is associated with land owned by local cultivators who have an individual and legal title to the land. It is the single modern stable form of land use in the Arorangi District and in Rarotonga as a whole. The decline in the harvest from wild orange trees necessitated the innovation of a citrus replanting scheme to prevent the extinction of a valuable limb of the insular economy.

As for many of the crops already considered, the makatea and the swamp provide unfavourable habitats for citrus crops (Fig. 7). In other respects this mode of land use shows obvious contrasts. The neatly tended appearance, the geometrical spacing of the trees and the rectangular shape of the plots, which average one and a half acres in size, appear as paradoxical features in the common pattern of multiple land use found in adjacent sections. The compact and orderly arrangement, the leguminous cover crop, the mulch around the trees, the inter-planted dadap (*Erythrina*) to build up the nitrogenous content of the soil, the shelter-belts of *Albizzia,* pistache, false coffee and hibiscus, the extensive use of machinery, the regular spraying, the young citrus trees—all these and many other characteristics in association provide a major distinctive element-complex in the landscape (Plate II, bottom left).

The replanting scheme is sponsored by the Administration and the plots are maintained by the officers of the Department of Agriculture in co-operation with the local owners. This is itself significant but of possibly far greater consequence are the changes to the traditional systems of land tenure.

LAND TENURE

The question of land tenure has not only been vital to the success or failure of the replanting scheme, but it remains at the heart of many of the problems of contemporary land use. Only the broader aspects, with one specific example, are here discussed. No study of land use in the Cook Islands can afford to neglect the forms and problems of land tenure since they may, and frequently do, vitally influence the use, and misuse, to which the land is put.

Where subsistence food-crops are concerned the problem of land tenure is not particularly pressing as there is little conflict between communal ownership

1. For a detailed account of the citrus industry and the distinction between wild and cultivated oranges, see W.B. Johnston, 'The Citrus Industry of the Cook Islands', *New Zealand Geographer,* Vol. 7, 1951, pp. 121-39.

and the right of the individual to use land. Where long term crops for sale are concerned the position is basically different as the occupier has a greater interest and at the same time land is removed from food production.

The Arorangi District encompasses one of the three tribal groupings in Rarotonga. Land has always been the great object of ambition and it is illegal for a native to sell land. The breakdown of the power of *tapu* with the advent of Christianity has practically destroyed the hierarchy of tribal power. The important unit in the present system of land tenure is the extended family—known as *kopu tangata*—which is traditional throughout Polynesia. In the Arorangi District the land belonging to each *kopu tangata* includes a cross-section from the lagoon to the interior. This unit of land is termed *tapere,* of which there are nine in the District.

Within the *kopu tangata* the custom is to allocate to each member a specific portion of the *tapere* for use and occupation. Custom decrees that the allotment belongs to the occupier for life and, thereafter, to his children. An inaccurate interpretation of native custom about 1900 has greatly complicated the problem of land tenure.[1] Whereas patrilinear inheritance was customary the reforms enforced bilateral inheritance. For a period land-owning and land-using groups were generally similar and this allowed a considerable degree of security of tenure. With increasing population and the passing of each generation, the land-owning groups soon outran the local land-working groups as those who had interests in the land fragmented. The increasing divorce of land-owners and land-users has meant growing insecurity of tenure as the reduction in the proportion of those owners who actually use the land continues. It is necessary to remember that this does not mean excessive fragmentation of land use but it does result in groups of co-owners becoming so large and so dispersed that co-operation is extremely difficult to arrange, while tenure for the actual users of the land becomes much less secure, all of which hinders agricultural development. The magnitude of the problem is clear when an estimated 12.5 per cent of the land-owners are believed to live in New Zealand while many others live on distant islands.[2]

All the family blocks of land in the District (and in the rest of the island) are fixed by survey. A Court Order for family lands is highly valued for it represents a firm title against European infiltration, but the native is distinctly averse to a similar partition of land among the members of the family, or to the individualization of owner's interests. In many cases the land is parcelled out to members of the family and only the owner of the block can define who is the nominated occupier of each section. The fundamental distinction between individual partition by Court Order and allocation by title-holders is important. The latter is customary; the former is an unpopular innovation.

The communal ownership of land with its obligation to support other members of the family gives a refuge for all. However, the sharing of produce from the land, or of revenue from the sale of crops grown on family land, has, under the contemporary economic conditions, limited the energy and enterprise of people who are naturally progressive. The problem has particular application

1. This section on land tenure owes much to the knowledge and advice of the Registrar (Mr. Tremm) and the Judge (Mr. Morgan) of the Native Land Court. For a detailed account of the origin and development of land tenure policy see R.P. Gilson, 'The Foundations of Cook Islands Land Policy', *South Pacific,* Vol. 7, 1954, pp. 948-55; and 'The Background of New Zealand's Early Land Policy in Rarotonga', *Journal of the Polynesian Society,* Vol. 64, 1955, pp. 267-80.

2. Belshaw and Stace: op. cit., p. 77.

to commercial land use and many of the reasons for the neglect of land and crops can be traced to the fragmentation of land ownership and its divorce from the land users.

Security of tenure was necessary before any scheme to resuscitate the declining citrus industry could be commenced with prospects of success. The effective solution merits discussion in view of the importance of the question. Recommendations are made to enable one member of the *kopu tangata* to have, by communal agreement, a definite area of land. The intricacies of communal ownership are investigated and individual occupation rights determined by a careful procedure involving a combined meeting between the occupier, who desires an individual right, all available owners, and the Registrar of the Native Land Court. A survey of the area is made and the section plotted. Upon agreement, by a general meeting in the Native Land Court, the occupier is confirmed as the owner under Maori custom and, significantly, he becomes capable of pledging the freehold to the Administration as security for financial and material advances. The method, based upon that employed in the investigation of land titles for the development of Maori land in New Zealand, has circumvented the major objections that were made to earlier proposals.[1]

This example illustrates some of the complexities involved in designating a secure and legal individual title to land, and at the same time satisfying all the parties concerned. Yet it is only one method. In some cases and for some crops it can be argued that the communal system provides a persistent and powerful custom to be harnessed and incorporated into the money economy and not to be destroyed by individualization of the family land.[2] This is one approach that is being followed by the authorities in Fiji,[3] and is being tried with copra production in some islands of the Cook Group.

THE LAND-USE PATTERN

Within the relatively small area of the Arorangi District there is considerable differentiation in the land-use patterns of single crops. The differences and similarities have been related to the two basic factors of the physical character of the land and the economic competition for land. Specially related to the former is the location of taro in the swamp; the latter is well illustrated by the relative absence of coconut palms on the fertile soils of the main agricultural areas.

1. The order granting right of occupation is made on various conditions, the most important of which are as follows:
   1. 'The land shall be used for the purpose specified (on the Order).....'
   2. 'The occupier may not lease or transfer his right of occupation.....'
   3. 'On the death of the occupier, his occupation right shall pass to his children and registered adopted children who shall decide, subject to the approval of the Native Land Court, who of those children or adopted children shall occupy. If the occupier leaves no children or registered adopted children then the successors appointed by the Native Land Court shall decide who shall occupy.'
   4. 'If an occupier leaves the Island ..... or if he fails to use the land for the purpose ..... granted or if he fails to use it in a proper and husband-like manner or if ..... he abandons the land ..... then the owners or the next of kin ..... may, with the approval of the Native Land Court, appoint a new occupier ..... '
   5. 'Any disputes will be settled by the Native Land Court.'
   Cook Islands Amendment Act, 1946, Section 50.
2. F.M. Keesing, 'Extension Work in Pacific Islands', *Rural Sociology,* Vol. 9, 1944, pp. 311-27.
3. See 'Annual Reports of Registrar of Co-operative Societies', *Council Paper,* Legislative Council, Fiji.

The areal differentiation of the complex pattern of land use is singularly striking (Fig. 9). The non-agricultural land is closely associated with the steep slopes, narrow valleys and radiating razor-back ridges of the volcanic mountainous interior (Plate II, bottom right). On the agricultural land a threefold regional division may be recognised.

The first region is the taro swamp consisting of a narrow zone of wet low-lying land of discontinuous, irrigated, taro plots separated by undrained and uncultivated swamp. It is noted for the specialized and restricted form of land use, and, where uncultivated, it is occupied by swamp vegetation in which guava and hibiscus are prominent. (Fig. 8).

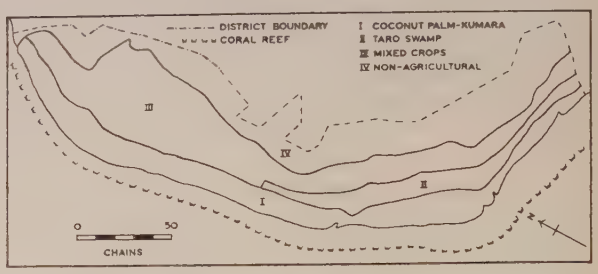


Fig. 9. Land-use divisions of the Arorangi District.

The second region consists of the coastal *kumara*—coconut palm belt which is clearly related, in outline, to the calcareous soils of the makatea. Along the shoreline is a narrow zone of sand beach vegetation. On the makatea, considerable areas have reverted to secondary forest in which *Barringtonia* is particularly common. Many of the reverted areas are accounted for by the large proportion of hard coral lumps, often ten inches across, in the soil. More frequently, however, the dominance of secondary forest results from neglect of the land. Of the field crops only *kumara* is grown extensively on the inherently infertile soils. In favourable parts tomatoes are seasonally grown. But it is subsistence *kumara* and coconut palm, frequently in association, which are the distinctive elements in the land use.

The third region is one of mixed land use, and constitutes the major agricultural area. It includes the well drained fertile soils of the depression and of the terraces and fans. All crops, except taro, are grown. Here are the important commercial crops of oranges—both wild and cultivated—and tomatoes, as well as the basic subsistence crops of *taro tarua, maniota* and *kumara.* In contrast with the second region, the coconut palm is of minor importance. Here is found, *par excellence,* the variety of crops from area to area, from season to season and from year to year which is the most impressive and characteristic feature of the land use. Yet despite the agricultural importance of the region there is a large total area lying fallow in weeds, or under scrub and secondary forest (Fig. 8).

Animal husbandry contributes very little to the character of land use although almost every family has a few fowls and pigs which largely forage for themselves. The unconfined maraudings of both are responsible for frequent damage to crops. But on the whole animal husbandry remains an unknown science to the local people.

The major changes in land use occur in concentric belts about the centre of the island. The sea, fringing reef and shallow lagoon provide sea foods for the local population. The low coastal makatea of raw soils is differentiated primarily as the site of the ribbon village, of a large number of rural dwellings and of the main line of communication—the coastal road. Further distinction is added by the use of large areas of the makatea for the growth of coconut palms and by *kumara* as the key field crop.

Inland is the zone of low-lying land traversed by streams flowing between natural levees. Two distinctive subdivisions are recognised. To the north is a rich agricultural area producing abundant subsistence crops of *maniota, taro tarua* and *kumara,* and valuable commercial crops of citrus fruit, tomatoes and watermelons. This is a region of infrequent and dispersed rural settlement, each dwelling set amidst pawpaw, bread-fruit and mango trees. To the south are swamps and discontinuous taro plots separated by extensive areas of weeds and high scrub.

The fourth region is that of the agricultural terraces and fans, another important area for commercial and subsistence crops, and through which runs the *ara metua*—now a mere track frequently ill-defined. Here the rural dwellings are set in the midst of fruit trees and banana plants with a characteristic development of small food plots in the immediate vicinity—truly homestead gardens.

Rising abruptly inland is the extensive mountainous interior. It is agriculturally unimportant and supports no permanent settlement. As the catchment area for the rivers and reservoirs it is vital to the coastal lowlands while the forest cover furnishes timber, berries and wild fruit.

This pattern is repeated in the other Districts of Rarotonga with certain modifications, notably on the northern coast where the commercial, administrative and shipping centre of Avarua is situated, and in the south-east where the general concentric banding is incomplete. In the latter the makatea is replaced by a series of islets while the depression has been filled by the sea to form part of the lagoon. In essence, however, the Arorangi District provides a fair sample of the high island of Rarotonga.

THE DISTRIBUTION OF FOOD-CROP STORAGE METHODS IN NIGERIA

By W. B. MORGAN

THE HARVEST period of most crops in Nigeria is short and, in consequence, crop storage, particularly the storage of food-crops, is necessary to ensure regular supplies. Storage bins, pits or racks are a feature of most Nigerian households. Despite the obvious importance of the subject in a country where the bulk of the food consumed must first be stored and where materials and equipment are limited, little has been written about storage methods in Nigeria. This is surprising in view of recent research in Nigeria into storage problems, notably into the problem of insect infestation.[1]

Apart from temporary storage, intended to last for only a few weeks until another supply of fresh food is available, there are two main types of food-crop storage in Nigeria. The first is short term storage of the chief food-crops for several months or even a year. This is the most common type of storage and occurs over most of the country. The second is long term storage for several years in order to balance fluctuating returns and prevent the occurrence of famine or the shortage of a particular food in any year. This form of storage is limited to the northern portions of the country, chiefly to northern Hausaland and Bornu.

The length of the rainy season and the liability of the rains to fail are two of the chief factors involved in food-crop storage. The latter is the chief consideration in the question of long term storage, and is indicated in Fig. 1 by the limit of the area liable to receive less than sixteen inches of rainfall in a year, and the limit of the area which may receive no rainfall in April. Recording stations are few and the length of records short. In consequence the limits shown must of necessity be highly generalized. An annual rainfall of sixteen inches may be considered the normal minimum required for cultivation. April (or May at the latest) is the month in which most planting takes place in the north and failure of rains then may be as disastrous as receiving an insufficient total during the growing season. The average length of the rainy season in the extreme north, that is the period with more than one inch per month, is approximately five months (Fig. 1).

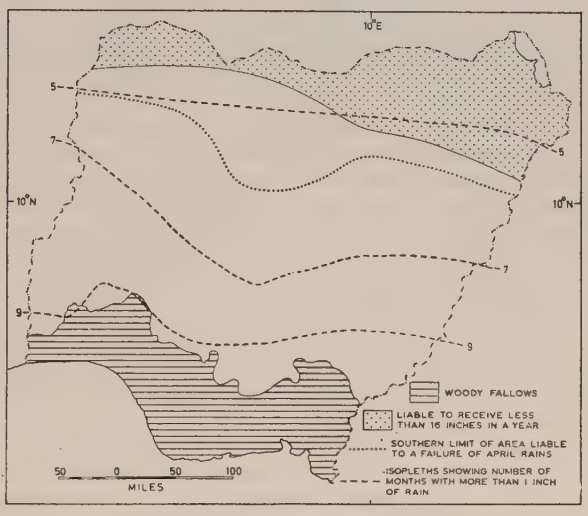
On the main cultivated lands of the northern border cropping is restricted to quick growing varieties of grain, chiefly pennisetum millets, and there is in effect only one short harvest period (Fig. 2). An exception occurs in eastern Bornu where 'masakwa', a variety of guinea-corn, is sown on moist clay soils at the end of the rains and harvested in December and January. Excepting the crops derived from floodlands, which are particularly important in the districts around Lake Chad and in Sokoto, food-crops must normally be stored for periods of about eleven months.

Further south in the area lying approximately between Kano and Bida the rainy season lasts between five and seven months and a greater variety of cereals can be planted. Here the planting of early and late varieties makes possible an extended harvest period so that storage is necessary only for about eight months. There is also a supplement from floodland cultivation, but its importance is less

1. 'Insect Infestation of Stored Food Products in Nigeria. Report of a Survey, 1948-50', *Colonial Research Papers*, No. 12, 1952.

than in areas further north. Between Bida and the northern limit of the area with woody plants in the first year of fallow (an area often confused with the climax rainforest) mixed cropping of roots and cereals is possible with a rainy season of seven to nine months. Cassava is especially useful since it will stay in the ground for two years or more after maturing. Cereals are still a staple food, and with a marked use of early and late varieties and even double-cropping, that is planting a second crop after harvesting the first, storage is only necessary for four to six months.

Finally in the extreme south there is the woody fallow area where the rainy season lasts for more than nine months, and high relative humidities occur throughout most or all of the dry season. In this area root crops are dominant and only maize, tolerant of more moisture, shows adequate returns for a cereal crop. Yams are almost the sole crop to which elaborate storage methods are applied.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WOODY FALLOWS
LIABLE TO RECEIVE LESS THAN 16 INCHES IN A YEAR
SOUTHERN LIMIT OF AREA LIABLE TO A FAILURE OF APRIL RAINS
ISOPLETHS SHOWING NUMBER OF MONTHS WITH MORE THAN 1 INCH OF RAIN
50 0 50 100
MILES

Fig. 1. Physical factors.

The variety of staple crops affects the length of the storage period, for generally the greater the variety the shorter the period in which a guarantee against food shortage is required. The choice of staple food-crops in relation to the environmental conditions determines the type of storage required. Thus in the south yam storage in humid air requires maximum ventilation. In the extreme north cereal storage in dry air is normally effected in sealed containers.

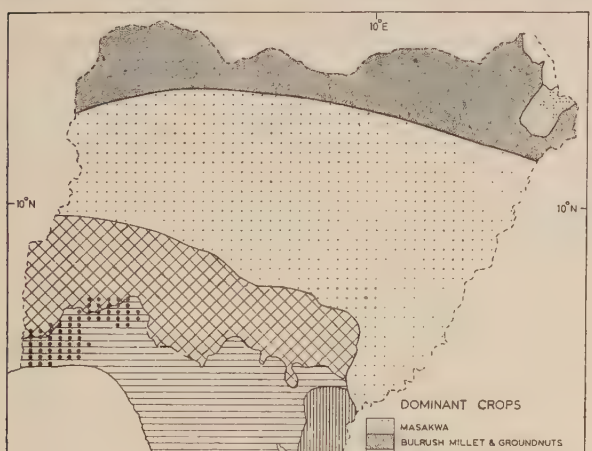

Fig. 2. Dominant crop zones.

Three major cropping zones may be distinguished in Nigeria (Fig. 2). The first is the roots zone in the south, with some maize chiefly in the west. This zone corresponds with the woody fallow zone, except in northern Iboland and in Ogoja Province where root cropping is dominant even in the savannah. The second is the mixed roots and cereals zone further to the north. The northern limit of this zone corresponds in the west and centre with the northern limit of the occurrence of two or more rainfall maxima in at least seventy-five per cent of the years for which there are

records. This is approximately the limit of high expectation of a long enough rainy season and sufficient rain to make root cropping worth while. North of this zone there are too many failures except where other moisture resources are available, and in the case of yams the rainy season is too short for the production of seeds after the main harvest. Exceptions occur where roots are preferred in the diet despite poor results. In the eastern part of the zone physically possible for roots the Jukun peoples still cultivate chiefly cereals, mainly because of tradition. The third is the northern cereals zone in which sorghum or guinea corn, pennisetum or bulrush millets, digitaria and eleusine provide the staple food. There is a tendency for the quicker maturing pennisetums to be dominant in the north and the longer maturing but more productive sorghums to be dominant in the south.

The time of harvesting and whether or not a crop is important commercially are both factors in crop storage. The time of harvesting is important since the type of storage and of drying depends on whether the crop is harvested during the wet or the dry seasons. If the crop is harvested during the wet season careful drying is needed. The Nupe use specially constructed ovens for drying a crop of early bulrush millet during the rains before putting it in store. Clay bins cannot be built easily during the wet season and therefore must be constructed in advance. If such bins are not built, or are insufficient, then temporary storage must be effected in well ventilated grass bins subjected to frequent treatment of smoke. Commercial crops frequently need temporary storage in grass bins, on racks or on special drying platforms whilst awaiting transport to market. Storage in the village, however, rarely needs to be for more than a few weeks and often only for a few days. The main problem with commercial crops is storage in transit particularly whilst awaiting transport by railway. The problem of the groundnut pyramids at the major collecting points in the Northern Region provides an obvious and well known example.

FOOD-CROP STORAGE REGIONS

On the basis of the types of storage and the factors involved, it is possible to recognize four major food-crop storage regions in Nigeria, each with its own distinctive patterns of storage and its own problems. These are generalized in Fig. 3.

(1) *The temporary and short term roots storage region.* In this region yams may be stored for several months and maize usually for only a few weeks. Cassava is harvested when required and cocoyams are only a minor crop except in the Southern Cameroons where the cormels are frequently removed when needed without unduly disturbing the plant. In consequence, storage in the Southern Cameroons is of only minor importance. Yams are normally stored in racks shaded and sheltered by a covering of palm leaves and by the foliage of live 'poles'. The

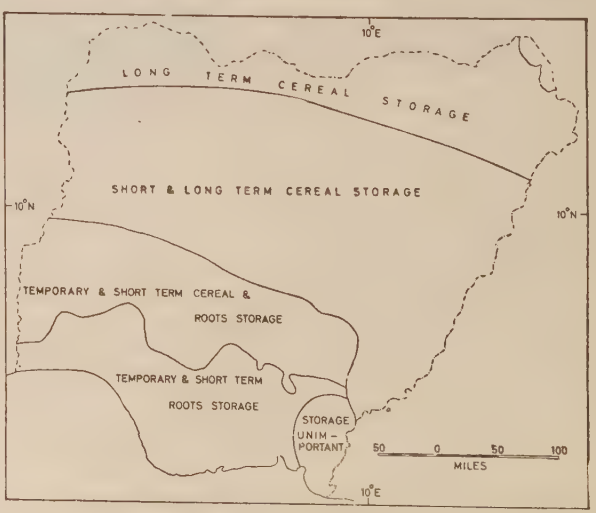

Fig. 3. Food-crop storage regions.

yams are arranged in a manner which allows the maximum ventilation for drying purposes. It is claimed that in some areas, notably in Southern Iboland, this method of storage is necessary in order to dry seed yams intended for planting at the beginning of the rains in March to May. It is suggested that without drying the seed yams will not sprout. Maize storage is usually effected in well ventilated grass bins. Sometimes smoke is used to keep away insect pests, particularly weevils, whilst the heat of a fire helps to dry the grain.

(2) *The temporary and short term cereal and roots storage region.* The chief problem in this region is the provision of an adequate supply of a particular crop for a few months of the year. Yams are usually stored within the living quarters or in pits. Planting takes place in most cases during the dry season from November to January and seed storage is unnecessary. Lower relative humidities make storage without ventilation possible. The northern Yoruba often use large mounds lined with ash, whilst the Tiv employ special trenches or the mounds formerly used in cultivation or deep pits over which small mud walled and thatch-roofed structures are erected.[1] In some cases yams are cooked and dried before storage in a form which will keep well and may easily be broken up into flour.

In the moister southern portions of the region the Northern Edo-speaking or Kukuruku peoples stack yams on high well ventilated platforms. Grain storage, if temporary, is effected in grass bins. On the croplands these are not very elaborate, but in the compounds they are carefully woven and are often large containers suspended on a framework raised on poles and covered with thatch. In this way some protection may be obtained from termites, vermin and floods. This type of structure has the advantage of being easy to fumigate against insect infestation by lighting a fire underneath. Unthreshed maize, guinea-corn and millets are commonly stored in this manner, and by being unthreshed allow more air circulation in storage. Grass bins are often used for temporary storage before transfer to more permanent structures. In this respect they are useful in field camps situated at some distance from the main household. Short term grain storage is achieved by the use of mud bins open at the top, except for a covering of thatch. Air circulation in such bins is important to prevent mould and the grain must be dried beforehand since fumigation in storage is impossible. Mud stores of this type, commonly referred to by the Hausa word 'rumbu', consist usually of cylinders of clay accessible either through the thatch covering, through small doors in the side or through a hole in the wall plugged with a stone or with clay or usually with both. The Nupe frequently build structures of this kind as part of the compound wall (Fig. 4). Rumbus may be built directly on the ground wherever there is no danger of damage by surface run-off, or raised on posts, or on a clay pedestal or clay legs, or even supported on a foundation of stones. The Tiv of this region use a distinctive method for storing ground-nuts. The nuts are placed in small cones of clay covered with thatch and supported in an inverted position on wooden frames.[2]

Fig. 4. Nupe dwelling hut and short term storage bin.

1. P. Bohannan 'Tiv Farm and Settlement', *Colonial Research Series,* No. 15, 1954, pp. 15 and 17.
2. Ibid. p. 16.

(3) *The short and long term cereal storage region.* The chief problem in this region is to provide an adequate supply of a particular crop throughout most of the year. Temporary storage is less important and is confined chiefly to the crop-land where food-crops may await transport to the village after harvest. Short term storage is very important and involves the use of large rumbus, sometimes of very elaborate design and construction (Fig. 5).

Formerly the region was one of great insecurity and defence needs have affected the forms of storage amongst many peoples. Thus the peoples of the Jos Plateau and of Nassarawa have grain stores inside their huts. In some instances huts are two storeyed with the grain store in the upper chamber. Some peoples leave the upper grain store open to the smoke of the kitchen fires and preserve their food by constant heating and fumigation. In other instances the grain store consists of a central cylinder within the hut walls, the intervening space being used as sleeping quarters. Long term storage in the region is of lesser importance, and occurs in some cases because of the past tradition of insecurity, and in others because of low productivity and the danger of food shortage in any one year with even a small decrease in crop returns.

Fig. 5. Short term storage bin near Randa to South-west of Jos Plateau.

On the Jos Plateau and in surrounding districts this form of storage is usually in a mud cylinder on a pedestal, or directly on the ground with a clay sealed top over which a covering of thatch is placed to prevent erosion by rain. Access is usually through a hole in the side, also sealed with clay. Great care has to be taken in the construction of these cylinders for erosion of the top or base by rain or groundwater, or cracking during the dry season, will result in the loss of grain. Pit storage has not been unknown in the region. The Katab peoples, for example, used pits as a protection against the raids of enemies. The pit was dried with wood fires and, when filled, was closed over except for a small entrance blocked by a stone plastered with clay.[1]

In the Yauri district of the Niger Valley there is a distinctive method of storing onions—an important commercial crop. Whilst awaiting shipment the onions are placed in a bin with a cornstalk floor permitting air circulation and raised on wooden poles to be above ground level.[2]

(4) *The long term cereal storage region.* The chief problems here are storage against an actual food shortage, and storage in order to have an adequate supply for

1. C.K. Meek, *Tribal Studies in Northern Nigeria, Vol. II* (London, 1931), pp. 45-6.
2. P.G. Harris, 'Notes on Yauri, Nigeria', *Journal of the Royal Anthropological Institute,* Vol. 60, 1930, pp. 283-334.

most of the year of a particular crop. Long term storage for more than a year is necessary in Sokoto, Northern Hausaland and Bornu because of the danger of insufficient or late rains with resultant crop failure or lowered returns in any one season. Pits are generally used, particularly in Bornu where large quantities of grain must be stored and where pits are comparatively easy to dig in the deep Eocene sands. In Bornu pit storage for periods of up to seven years is an important feature of the economic life. Periodically grain is removed from the pit and is stored for temporary or short term purposes in large grass bins, often more than six feet across and four to five feet in depth (Fig. 6). In these the grain is more readily accessible. The thatch roofs covering the bins provide sufficient protection during the short rainy season, and clay rumbus are unnecessary for short term storage.

Fig. 6. Storage Basket in Bornu.

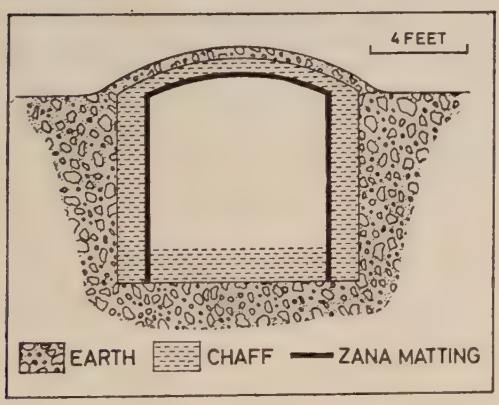

Fig. 7. Section through a storage pit in Bornu (after Hall, Haswell and Oxley).

Two types of pit store are used—the sands type and the 'tabki' type. In the sands type the pit is circular and normally with straight sides (Fig. 7). It may be up to fifteen feet or more in diameter and five to ten feet deep. No attempt is made to seal the walls, but the pit is lined with chaff and in turn the chaff is lined with 'zana' mats of woven grass. The unthreshed grain is dried, normally in the sun, before storing. After placing in the pit it is covered with zana matting, chaff and a layer of earth. This cover is raised above the surrounding surface level to promote drainage and is protected by a layer of thorns. One Kanuri practice, according to Meek, is to line the pit not with zana matting and chaff but with cornstalks and ash.[1]

Tabki storage takes place in the sands-with-clay portion of the Chad basin, chiefly in Dikwa Emirate. Here surface depressions accumulate clay deposited by rain water percolating down gentle slopes. Eventually clay beds are formed sufficient to hold a wet season pool or tabki. The trampling of cattle brought to the pools to drink increases the imperviousness of the clay. In the dry season the cultivator selects a suitable clay patch and digs a circular hole down to the underlying sands where he hollows out a concave sided pit. The pit is lined with

1. C.K. Meek, *Northern Tribes of Nigeria, Vol. I* (London, 1925), p. 132.

matting and chaff, filled with grain, covered with matting and the clay plug replaced. Water may return in succeeding wet seasons and the surface may even bear a crop, but the grain usually remains well stored beneath the clay for several years.[1] Tabki pits are normally used to store masakwa.

With regard to long term pit storage in general, pennisetum millets are claimed to have better keeping qualities than the sorghums or any other local cereal. The popularity of pennisetum millets as a crop in the extreme north of Nigeria may therefore be as much influenced by storage questions as by moisture and soil problems in relation to growth.

There is a good case for attempts to improve indigenous storage methods since losses due to infestation by insects, vermin and other pests, or due to mould, are not uncommon. Improvement would clearly provide an increase in Nigerian food supplies without extra productive effort. This would be especially useful in the northern areas where storage is necessary to guard against food shortage resulting from crop failure. Any increase in food supply due to the use of better storage methods will, moreover, be maintained proportionately in all years. However, costs and the problems of technical complexity must be borne in mind. New methods must be simple and use only cheap materials to replace the existing storage facilities. Little or no maintenance must be required as the Nigerian cultivator is fully occupied in working his small 3 to 6 acre holding. Whilst further study of Nigerian crop storage may be usefully directed towards the question of improvement of local methods, some of the information gained may be of application elsewhere. Hall, Haswell and Oxley have demonstrated the value of the comparative study of local underground grain storage methods in discussing the problems of particular applications in various regions of the world.[2]

1. Brynmor Mones, 'Dessication and the West African Colonies', *Geographical Journal*, Vol. 91, 1938, pp. 401-23.

2. D.W. Hall, G.A. Haswell and T.A. Oxley, 'Underground Storage of Grain', *Colonial Research Series*, No. 21, 1956.

THE EVOLUTION OF RURAL SETTLEMENT IN EGBA DIVISION, NIGERIA

By AKIN L. MABOGUNJE

THE STUDY of settlement geography in West Africa has, up to date, concentrated largely on urban centres, particularly those which have changed considerably during the last hundred years as a result of increasing trade with the outside world. This study, however, is concerned with rural settlements, and its purpose is to show how the evolution of such settlements in a part of south-western Nigeria has affected every aspect of economic activity in the area.

Egba Division lies mainly within the Low Rain Forest Belt which is found in West Africa roughly between latitudes 5° and 8°N. (Fig. 1). Physically, it is made up of two major regions: a northern, highly dissected peneplain of ancient metamorphic rocks 400 to 700 feet high; and a southern undulating lowland region of less than 300 feet and consisting of younger, sedimentary rocks of Cretaceous and Tertiary age (Figs. 2, 3, 4 and 5). The younger rocks are made up largely of sandstones except for the exposure of shale in the low-lying swampy Itori Flats. Climatically, a line of division runs from north-east to south-west, and separates a wetter and wooded south-eastern region from a drier north-western region with a derived savannah vegetation (Figs. 6 and 7).

Agriculture provides employment for more than 80 per cent of the population of the Division. In general, the vegetational boundary separating derived savannah from forest is also an economic dividing line. The derived savannah areas are predominantly food-producing, concentrating on cassava (manioc) in areas within approximately eight miles radius from Abeokuta town, and on yams further away. Other crops grown in the derived savannah areas include maize, guinea-corn, cowpeas, melon and vegetables. Scattered stands of oil-palm yield a little palm oil and palm kernels for export.

The forest areas are predominantly cash-crop producing. In the north-east cocoa is most important and its cultivation is still spreading. In the south-west kola trees share pride of place with cocoa. It is dominant on the sandier soils of the younger sedimentary rocks and, because of its greater tolerance of poor soil, it is tending to displace cocoa trees where these have passed their prime of production or are diseased. Fruit trees, especially oranges, grapefruit and pawpaw are grown. Cassava cultivation is important, but for a different reason to that in the derived savannah areas. Here, although yams can be grown and is preferred, cassava has the advantage of fitting much better into the cocoa-farming calendar and of demanding less labour. Rice is also cultivated. Egba Division has the oldest history of rice cultivation in the southern half of Nigeria.

A remarkable fact about Egba Division is its high density of rural settlements (Fig. 8). The Division occupies 2,109 square miles and is one of two that make up Abeokuta Province.[1] In 1952 it had a population of 393,800 of which 21.6 per cent lived in the town of Abeokuta the Divisional headquarters. Apart from two other settlements—Otta and Ifo, each with over 8,000 inhabitants—the population lives in settlements of less than 5,000 people.[2] The majority live in small

1. The other Division is Egbado to the west.

2. The 1952 Census of Nigeria designates any settlement with fewer than 5,000 inhabitants as a village.

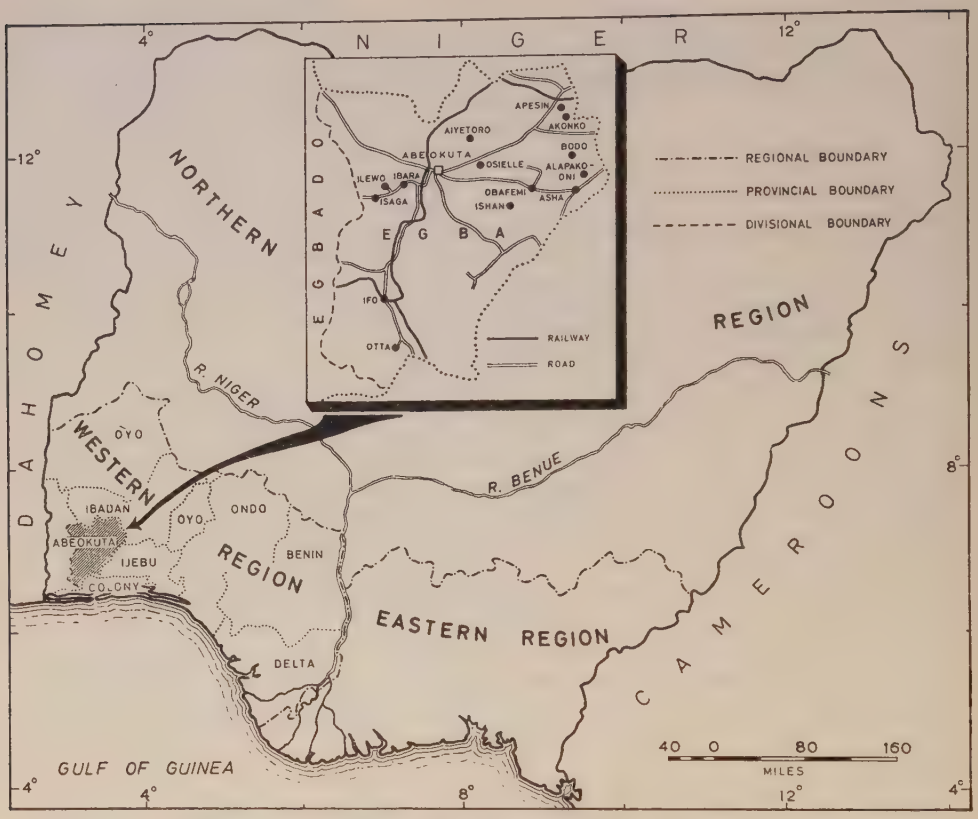

Fig. 1. Nigeria, showing the location of Egba Division.

villages and hamlets of less than 200 inhabitants (Fig. 9). The Division has over 3,000 small settlements of this kind giving an average of seventeen rural settlements per ten square miles.

The significance of this becomes clear only when the Division is seen in the setting of the Yoruba country. The Yoruba people are the dominant group in south-western Nigeria, and are noted, among other things, for living in large urban settlements. Small villages and hamlets were of considerably less importance until comparatively recent and more peaceful times. Egba Division is therefore remarkable for its abundance of small rural settlements and relatively few settlements of urban status. Whilst most Divisions in the Yoruba country have fewer than two settlements with a population of less than 5,000 people per ten square miles, Egba Division has seventeen (Fig. 8). Ibadan Division, which has fourteen, includes a large part of what was formerly Egba country, whilst the Colony Division with its seven rural settlements per ten square miles has had a large incursion of Egba farmers in recent years.

The 1931 Census of Nigeria, more than that of 1952, was concerned with the whole problem of settlement size and distribution. It offered the following explanation for the phenomenon of high rural settlement density in various parts of Nigeria: 'Full details of the distribution in towns and villages. . . . show the existence of 22,185 towns and villages in Nigeria, with an average of 16.8 square miles for each dwelling aggregate. In the Northern Province, there are no less

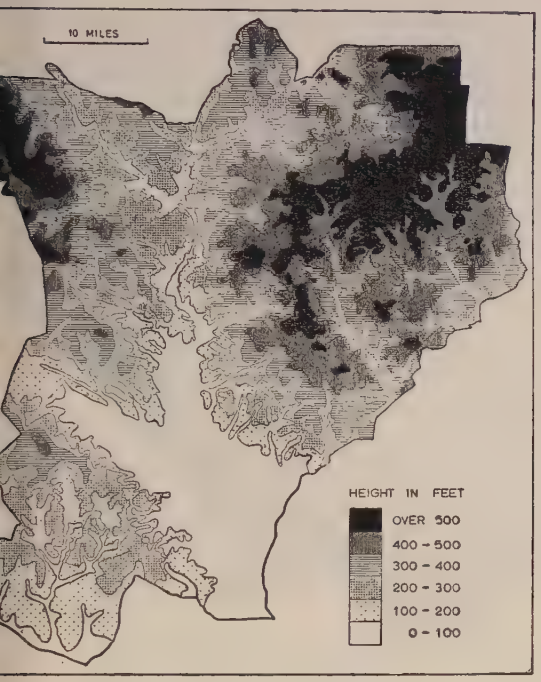

Fig. 2. Egba Division, relief.

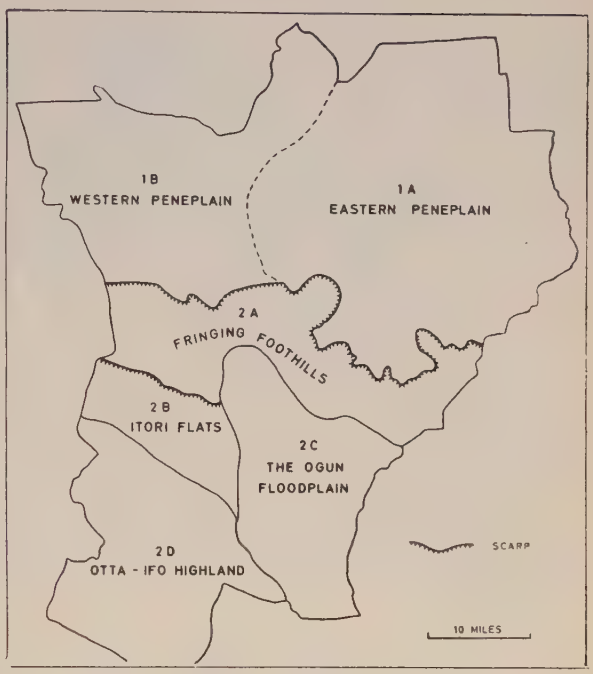

Fig. 3. Relief sub-regions.

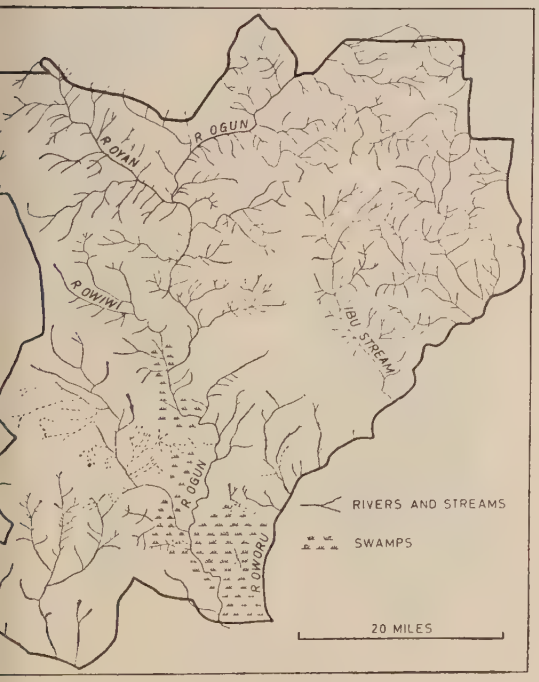

Fig. 4. Drainage.

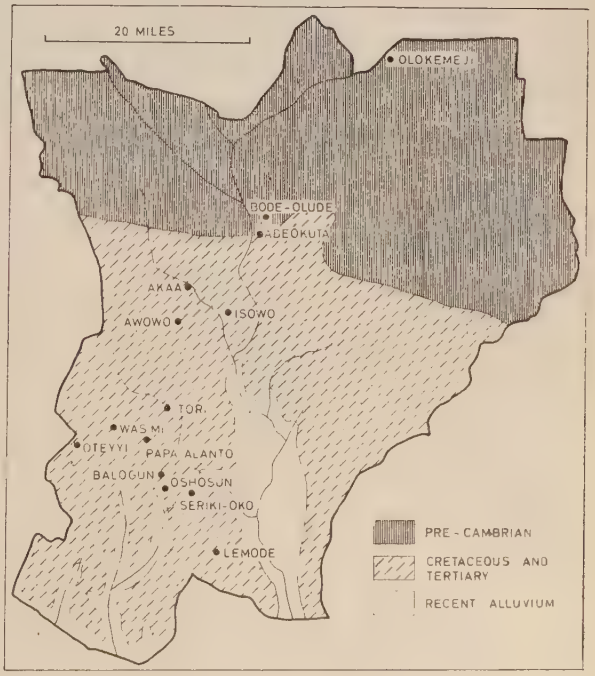

Fig. 5. Geology.

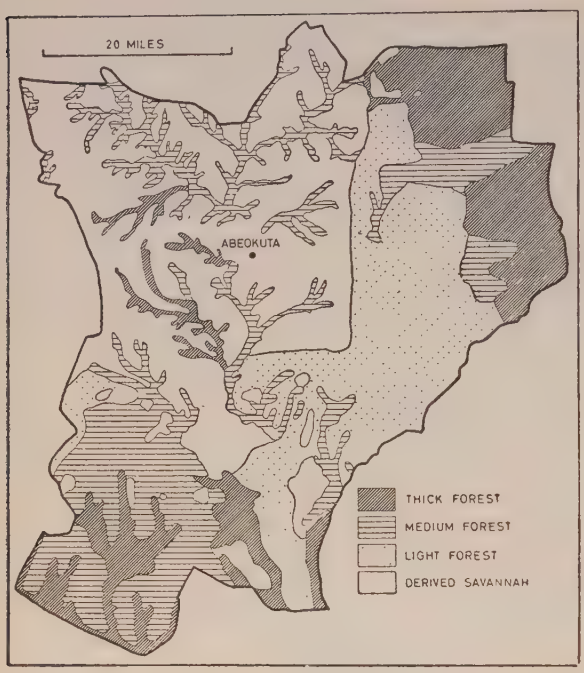

Fig. 6. Vegetation.

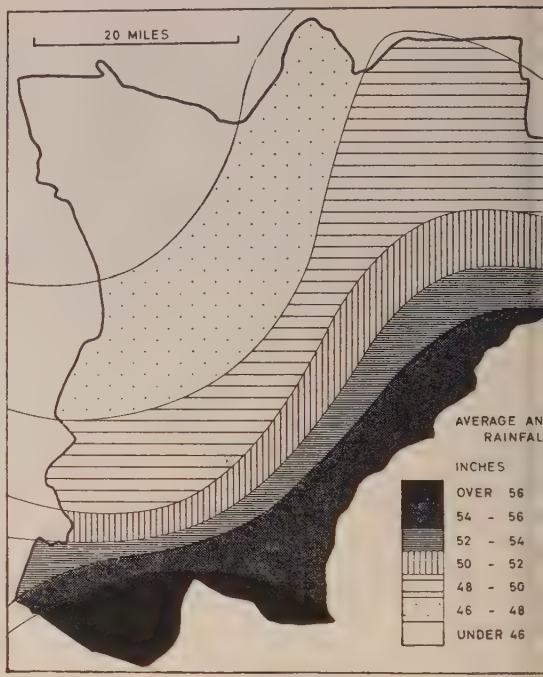

Fig. 7. Average annual rainfall.

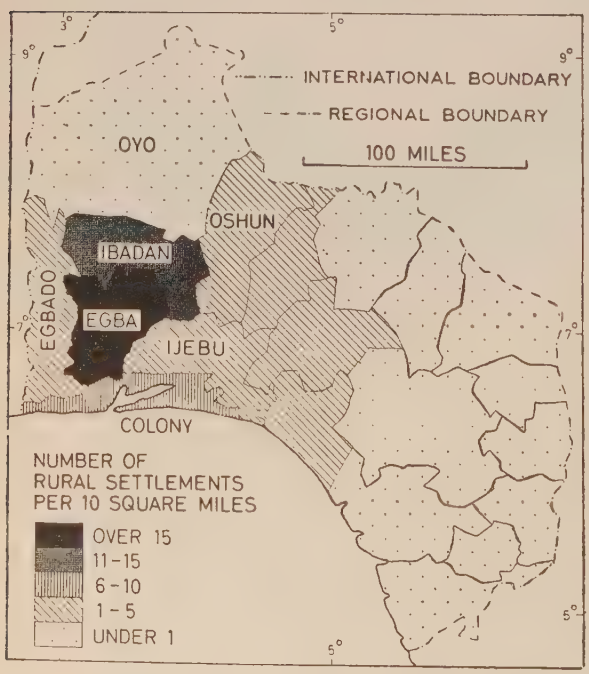

Fig. 8. Western Region of Nigeria, settlement density, 1952.

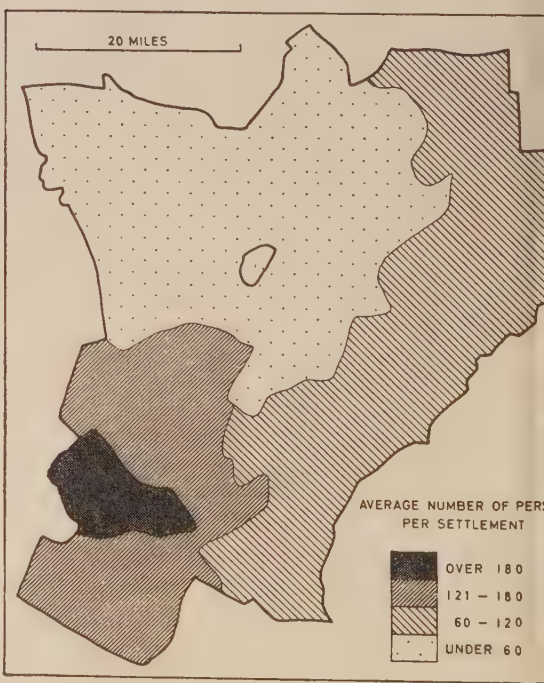

Fig. 9. Settlement size, 1952.

than 32.3 square miles per town or village as against only 6.7 square miles in the Southern Provinces. We may visualize this by saying that the average distance apart of villages is about 5.7 miles in the Northern as compared to 2.6 miles in the Southern Provinces. These distances must represent a balance between the two forces of *economic condensation,* arising from a tendency to cluster in trading and social centres, and *economic evaporation* which arises from the greater efficiency due to proximity to the land farmed. The latter tendency clearly cannot have had full economic play in the past, owing to a state of political unrest and the successive invasions from the North.'[1] The 1931 Census, in fact, recorded Egba Division as having 4,291 settlements[2] out of the total of 22,185. This means that a Division occupying less than 0.6 per cent of the total area of the country had about 18 per cent of the total number of settlements. In short, Egba Division was par excellence an area where the forces of 'economic evaporation' or dispersion had had full play.

This explanation, however, leaves many questions unanswered. For instance, it does not explain why the forces of economic dispersion had reached such dimensions only in this Division as against other parts of the Yoruba country; how the process had taken place; and if such proliferation of settlements really reflected greater efficiency in agricultural exploitation. To answer these questions, and indeed, to understand the evolution of this almost unique pattern of settlement, it is necessary to trace the historical geography of this part of the country from before 1830.

The early nineteenth century pattern

The present day Egba Division is not wholly occupied by the Egba people. It is now the home of four sub-groups of the Yoruba, with the Egba in the east, the Egbado in the west, the Ibarapa in the north and the Awori in the south (Fig. 10). The Egba are, however, the most important of these sub-groups. This is so not only because of their numerical superiority over the others but because of their political domination of the other sub-groups at one time or another in the past.

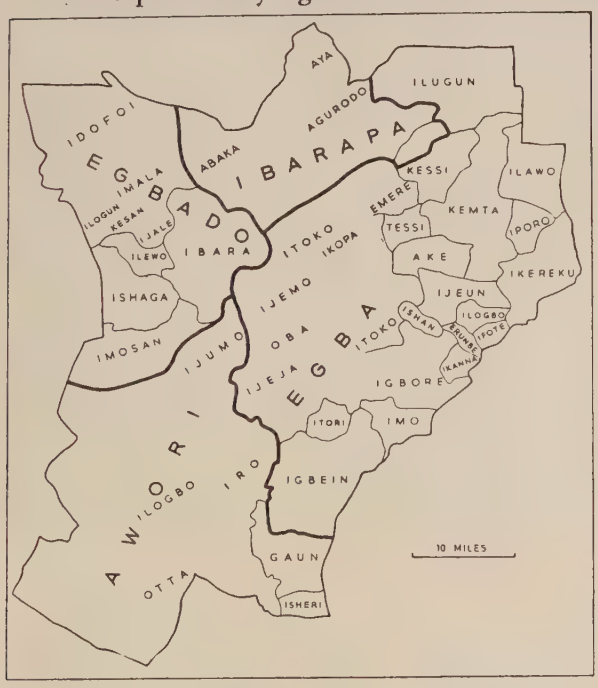

Fig. 10. Yoruba sub-groups and townships within Egba Division.

The Egba are said to be a small offshoot of the Yoruba people proper (that is the Oyo people), who prior to the nineteenth century occupied the south-eastern corner of Oyo territory. The approximate limits of present day Egbaland within this territory are shown in Fig. 11. At the beginning of the nineteenth century the Egba and their

1. *Census of Nigeria, 1931,* Vol. 1, (London, 1933), p. 13.
2. Only three of which were towns, i.e. having more than 2,000 people.

neighbours, like the other sub-groups of the Yoruba people, were settled in a series of small towns.[1] One Egba historian gave the total number of Egba towns as 300 and emphasised that they were organized into three provinces, namely, Egba Alake, Egba Oke-ona and Egba Agura.[2] Blair, and more recently Biobaku, suggested that this provincial organization had its origin in three waves of migration of the Egba from the original Yoruba homestead at Ile-Ife, each wave having given rise to a province.[3]

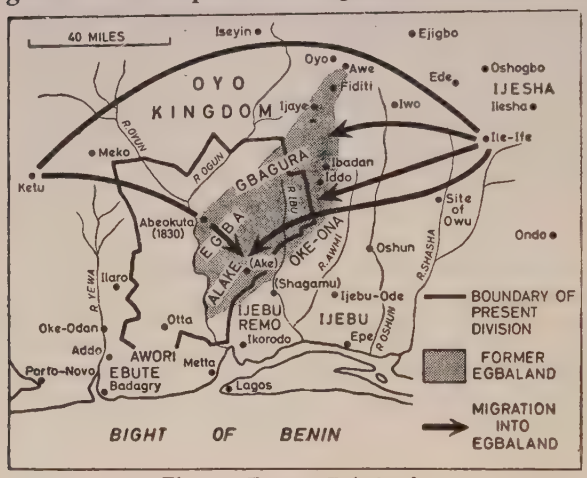

Fig. 11. Former Egbaland.

The physical character of the towns in these former Egba Provinces may be assumed to have resembled that of many small Yoruba towns that have survived from before the nineteenth century. The plan of the towns was usually concentric. In the centre was an open space, which served as a market. Surrounding the market was the built-up area, then came the first town wall and ditch, then the forest, and finally the second wall and ditch. Beyond the latter lay the cultivated land of the town. There were a few roads which led to neighbouring towns.

The obliteration of the early nineteenth century pattern

The early nineteenth century saw the beginning of many inter-tribal wars, the total effect of which was to efface most of the towns in a large part of what was then Egba territory. These wars were, in a sense, part of the chain reaction caused by the Fulani invasions[4] of the northern part of the Yoruba country. The effects of these invasions on the geography of the Yoruba country were twofold. In the first place, they gave rise to a southward movement of people who enlarged the population of towns at the contact zone of forest and savannah—areas where the military forces of the Fulani, based on cavalry, could not penetrate. Secondly,

1. Controversy still rages over whether these settlements were really towns or only large nucleated villages. The Censuses of Nigeria used arbitrary statistical criteria to differentiate between a town and a village. A town was any settlement with over 2,000 (1931 Census) or 5,000 (1952 Census) people. No final statement can be made on this issue until more detailed investigations have been made about the character and functions of many such settlements still found over most of the Yoruba country. The Yoruba people, on the basis of other criteria, differentiate between towns and villages, calling the one 'ilu' and the other 'abule'. As this article is not concerned with towns as such, it abstains from joining in the controversy, and prefers, for the present at least, to regard these settlements as towns because the Yoruba people regard them as such.
2. A.K. Ajisafe, *The History of Abeokuta* (Lagos, 1924), p. 20.
3. J. Blair, *Intelligence Report of Abeokuta* (1937), para 91; and S.O. Biobaku, *The Egba and their neighbours, 1842-72* (Oxford, 1957), p. 3.
4. Early in the nineteenth century, the Fulani, a race of nomadic herdsmen in the savannah lands of West Africa, rose against their Hausa hosts in a holy war of religion and conquered most of the Hausa states of Northern Nigeria. Later, a rebellious Yoruba general invited some of their mercenary troops to Ilorin to support him in his defiance of the traditional authority of Yorubaland. Even before the death of this general, the Fulani had gained control of his domain and used it as a base for further onslaught on the northern parts of the Yoruba country.

and more important, by intensifying the pressure of population in this zone, the Fulani raids were indirectly responsible for the series of minor invasions by which comparatively weaker sub-groups of the Yoruba people were pushed farther and farther south.

One of these sub-groups was the Egba. About 1817 there began a series of engagements with the Ibadans and their allies, as a result of which all the Egba towns were destroyed and much Egba territory lost. Irving and Hinderer, who went through the old Egba territory late in 1854, noted at considerable length the amount of desolation left behind by this internecine warfare. Irving described a typical scene thus: 'On either hand, amongst the stalks of Indian corn, etc. were abundant ruins—ditches, gateways, walls, the foundations, doorways and ends of houses, from mere vestiges to walls eight to ten feet high. These were Bagurah (Agura) towns. An almost continuous series of small towns stretched formerly for miles in this direction; a "street of towns", as it was described to me by one who remembered them—Ogubonna, the Abeokuta chief—to whom I am also indebted for the names as they occur in succession from Ibadan to the river Ona. They were 1. Ira, 2. Ikereku iri, 3. Ilusakodi, 4. Ijaiye kekere, 5. Igbegbo, 6. Orun, 7. Idomapa.'[1]

With all their towns destroyed, the Egba migrated south-westward to found the present town of Abeokuta in 1830. Twelve years later, the first missionary arrived at this new town. Abeokuta came to play, for the next fifty years, an important role in the subsequent opening up of Nigeria to British influence. From the records and journals of missionaries we catch a glimpse of the manner in which this new town was settled—a fact which has great bearing on the eventual evolution of the rural settlement pattern.

Abeokuta was settled not as one single town but as a collection of towns in close juxtaposition. Inhabitants of each of the former Egba towns settled as distinct units within the new territory. Today they are regarded as wards of the town. However, for many years after 1830 each town still retained its hierarchy of dignitaries who continued to control the affairs of their own particular section.

Thus, the destruction of the former towns of the Egba people and the founding of Abeokuta marked the beginning of a new era. Abeokuta continued to grow, and a visitor in 1859 estimated its population at more than 100,000.[2] Its growth was accentuated by accessions, not only of people from neighbouring tribes who found within its wall greater security for life and property, but also by many of the liberated slaves who returned home from Sierra Leone. The greater security offered by this single large settlement made a return in peace time to resettle the sites of the former towns an unattractive proposition. Henceforth, the Egba became a people having only a single, very large town. The demands of agriculture, their main occupation, however, gradually forced them to move farther and farther away from the town in search of new lands, and, as peace returned, they settled more or less permanently in villages and hamlets near to their farms. In this sense therefore the year 1830 can be regarded as the end of a chapter in the historical geography of Egbaland.

The creation of a new 'living space'

The upheavals which forced the Egba to concentrate within the new town of Abeokuta meant a considerable loss of land. For, if their original territory

1. E.C. Irving, 'Journal of journey into the Ijebu country', *Church Missionary Society Intelligencer,* Vol. 8, 1856, pp. 65-72. The exact location of these towns is now uncertain, they were probably not far from the north-eastern boundary of Egba Division.

2. R. Campbell, *A Pilgrimage to my Motherland, 1859-60* (London, 1861), p. 33.

included towns such as Ibadan, Awe and Fiditi, which are today well outside the boundaries of the Division, they must have lost between one-third and two-thirds of their land. For an agricultural population farming by the wasteful bush fallow method, such a shortage was bound to lead to encroachment on the lands of neighbouring tribes.

Moreover, within the area left to them of their former territory, they still had to contend with Ibadan forces. During the trek of 1830 to the site of Abeokuta, they had founded a military outpost at Osielle and another in 1879 at Aiyetoro to warn against movements of the Ibadan armies. In the area between these outposts and Abeokuta, they concentrated much of their agricultural activity, for beyond the outposts much kidnapping and brigandage went on, and only the brave and the desperate would venture there in search of new land to cultivate. Thus, over much of the area east and north of Osielle and Aiyetoro the forest returned and reasserted its hold. Of a part of this forest, Cyril Punch commented in 1902: 'The Ibadans remained and are still in possession of Orile Odo and part of the Orile Oko forest.[1] The latter part being a somewhat doubtful possession, the Ibadan Council generously allowed the Lagos Government to make it into a Reserve.'[2]

The need for more and more land forced the Egba, soon after they were established at Abeokuta, to start on a war of conquest and expansion at the expense of their weaker neighbours. To the east and south-east they were checked by the combined forces of Ijebu-Remo towns. To the west, their expansion began at first by a process of peaceful infiltration into the lands of friendly Egbado towns. In return, they offered the inhabitants of these towns (Ibara, Ishaga and Ilewo) safe refuge in Abeokuta during succeeding Dahomian invasions[3] in the latter half of the nineteenth century. The rest of the Egbado people, as well as the Ibarapa to the north and the Awori to the south, were subdued by armed force and many of their towns were destroyed between 1832 and 1870.

Pushing out in all directions, the Egbas succeeded in creating for themselves a new living space, which has become the present-day Egba Division of Abeokuta Province. Behind the movements of the Egba armies followed their farmers, peacefully but effectively occupying the lands of their conquered neighbours, and spreading back as far as possible into their former territory. The hunter-group was in the vanguard of this radial movement from the base at Abeokuta, but was closely followed by tillers of the soil. As the distance from Abeokuta increased, it became more and more difficult for these people to return to the town at the end of each day's work. They therefore built fairly permanent structures to house themselves and their families in the new lands, and, unless there were rumours of war or when the important yearly festivals came round, they spent most of their time in their new rural settlements.

Thus, from the chaos of the early nineteenth century a new Egba landscape emerged. It was not a landscape of small towns with extensive farmlands around them, but one made up of a single large town surrounded by a whole litter of small, insignificant villages and hamlets, with populations on the average of less than 200 each.

1. The word 'Orile' refers to the site of former towns. The former towns of Odo and Oko were situated somewhere outside the north-eastern border of Egba Division.
2. Cyril Punch, *Inspection Notes*, September, 1902.
3. The phenomenal growth of the town of Abeokuta soon after its foundation in 1830 excited the jealousy of the King of Dahomey who made three attempts to destroy the town in 1851, 1862 and 1873. The line of march of his army was always marked by considerable desolation and depopulation.

The distributional pattern of rural settlements

To appreciate the details of the evolution of the rural settlement pattern, it is necessary to differentiate four regions within Egba Division: (A) the earlier settled Egba area; (B) the later settled Egba area; (C) the Egbado area; and (D) the Awori area (Fig. 12). Information for the differentiation into regions has been gathered from two main sources. The first and more important is field investigation. During a period of nine months in 1957, more than 200 villages were visited in all parts of the Division. The second source is documentary and consists mainly of journals of missionaries who worked in the Division from 1842 onwards, and the Intelligence Reports on various sub-groups of the Yoruba compiled by Political Officers between 1905 and 1937.

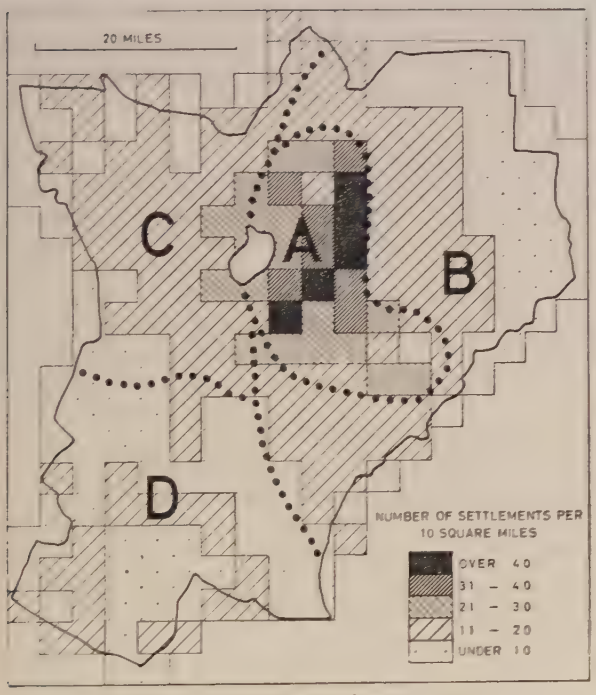

Fig. 12. Settlement density, 1939.

(A) The earlier settled Egba area

This region, which forms an arc north and south of Abeokuta, represents the area where for many years after 1830 the Egba were forced to concentrate their agricultural activity. The limits of the region were determined by the distance their enemies had retreated, and were fixed to the north and east by the military outposts at Osielle and Aiyetoro. Many village heads in this area asserted that because of the critical situation of those days, the inhabitants of towns here (Ijoko, Itoko, Oba, Ikopa, Ijeja and others)[1] were asked to waive their rights to their land. The intense pressure of population on the land which had necessitated this expediency led, in effect, to something of a grand scramble for land. People not only laid claim to small plots of land but also built a hamlet on it to make their claim effective. The result was the remarkable proliferation of small rural settlements in this region even though Abeokuta was within a few hours' walk.

Today, apart from the abnormally high density of rural settlements (about thirty to each ten square miles), the region is also characterized by the extremely small size of each of these settlements. The region, in fact, has the lowest average number of persons (less than fifty) per settlement, and has been steadily losing its population for a long time. The peasantry here farm by the wasteful bush fallow technique, and the considerably reduced period of fallow which a high density of settlement implied in the early days after 1830 led to rapid soil exhaustion, so that by the time peace came later in the century, this had become a very depleted zone.

1. Location uncertain.

Depopulation is evident from the shrunken size and widespread desertion of many villages and hamlets. In a number of instances, final desertion has been arrested only by the possibility of wresting some living from the collection of palm kernels and the growing of cassava. The most obvious evidence of depopulation is the number of houses in various stages of dilapidation. Further strong evidence is found in large villages, such as Ishan, where buildings, particularly churches and mosques, were begun on some grand scale but could not be completed on the same scale owing to loss of population in the interval.

(*B*) *The later settled Egba area*

Beyond the military outposts of Osielle and Aiyetoro, the land gradually returned to forest during the years of insecurity after 1830. By the time peace came later in the century this area was almost virgin land, and a large proportion of those leaving the depleted region (A) moved into these new lands. There followed a second scramble for land with the resulting further proliferation of villages and hamlets. Helping this movement to gather momentum was the system of inheritance by which the land was divided among all the children, male and female, of a man. The resulting minute holdings hardly proved economically attractive to the more energetic young men who often moved out to seek new land elsewhere.

Johnson, who traversed the southern part of this region in 1877, noticed that much of it was still uncleared and uncultivated.[1] Later in 1902, Cyril Punch went through the northern part and described how farmers were moving eastward and founding new settlements because the forest which had re-occupied this area in the last eighty years provided ideal conditions for the cultivation of the newly introduced tree crops, cocoa and kola-nuts.[2] Today, this area is the most important cocoa and kola-nut producing part of the Division, and is therefore the wealthiest. It is also an area to which people continue to migrate either as farmers in search of good cocoa land, or as labourers in search of seasonal wage-earning employment.

The increasing movement of population into this area and its new economic prosperity soon excited the attention of the elders of those former Egba towns which had land here. Though now residing in Abeokuta, these elders reasserted their rights over this land and proceeded to re-allocate it to descendants of former townsmen. Everywhere in the region, an investigator comes sharply against this fact of the continuing importance of the former pattern of town settlements on matters affecting land tenure and land holding. It was even possible from information gathered in this connection to reconstruct roughly the limits of the land of former towns, limits which had become considerably blurred in region (A).

Many of the settlements in this region are thus of comparatively recent date. Indeed, in a great number of instances, villagers here still remembered the date the villages were founded. Asha, the mother settlement for many of the villages and hamlets, was founded about 1890 as an outpost against further Ibadan ravages. Many of the other settlements are younger than Asha. Thus, Alapako Oni was founded in 1898, Bodo in 1910, Akonko in 1916, Apesin in 1922, and Obafemi in 1923. Obafemi, the District headquarters today, had been a 'market point'[3] a few years before 1923.

(*C*) *The Egbado area*

The Ogun River is the boundary between the lands of the Egba on the east and the Egbado on the west. Soon after 1830, the Egba infiltrated peaceably into

1. Rev. J. Johnson (Church Missionary Society) in a letter dated 21 June 1878.
2. Punch, op. cit., p. 9.
3. A 'market point' is an isolated clearing used for trading but not for residential purposes.

the lands of those Egbado towns (Ishaga, Ibara, Ilewo) which were near Abeokuta. Later, they destroyed most other Egbado towns (Kesan, Ilogun, Ipaya, Aibo, Afon, and others)[1] which were less favourably disposed towards them. What they did not destroy, the Dahomians laid waste on their way to besiege Abeokuta during the second half of the nineteenth century. Most Egbado therefore found refuge in hiding on their farms or by moving into Abeokuta itself. The Egba on their part spread out into the land of these weaker neighbours and by 1891, when the latter asked for British protection, they had reached to almost all parts of Egbadoland.

The highest density of rural settlements is still around Abeokuta and represents the initial overspill into Egbadoland during the period immediately after 1830. The average size of settlement for the whole region is still very low, being under sixty persons per village. Trends in this region are much as in region (A) with many shrunken and deserted villages and hamlets. In areas around the villages of Ibara, Ilewo and Ishaga (villages occupying the sites of former towns), the trend has been hastened by recent attempts to restore these villages to their former status as towns. The attempts take the form of encouraging farmers living within a three to five mile radius to desert their own settlements and move into these villages.

(*D*) *The Awori area*

South of Papalanto are the lands of the Awori. This region seems to have been protected for some time from the expanding wave of Egba farmers by the swampy country of the Itori Flats. The Awori, however, were concentrated in the town of Otta, and much of their land north of this town was only sparsely populated. From the end of the last century onwards, this northern part began to attract the attention of Egba farmers, particularly those of the Gbagura and Owu sections whose lands had been completely forfeited to the Ibadans during the wars before 1830. The big wave of migration of Egba farmers, however, came early in the twentieth century with the growing importance of cocoa and kola-nut cultivation. A population census carried out in this area in 1933, on the instructions of the Alake of Abeokuta,[2] showed that as against some 2,600 Awori in the Awori rural areas, there were some 9,000 non-Awori, more than two-thirds of the latter being Egba farmers.

Spottiswoode's Report stated that although some of these immigrant Egba farmers founded their own villages and elected their own *balés* or village heads, 'the majority, especially earlier immigrants, joined the Awori in their villages, and as a rule claimed no part in the village administration.'[3] The result of this tendency towards nucleation is to give this region the lowest density of rural settlements as well as the highest average population per settlement (160). The region also boasts of over thirty villages of more than 300 people and about ten of over 1,000 people.

South of Otta, the movement of Egba farmers has not, as yet, penetrated and rural settlement density is remarkably low.

Consequences of this pattern of settlement evolution

Four consequences stem from this pattern of settlement evolution. First, the proliferation of small rural settlements must be seen as almost concomitant with

1. The locations of Ipaya, Aibo and Afon are uncertain.
2. After the migration of the Egba to found Abeokuta, a new system of government was evolved for this new settlement and the head of the government came to be known as the 'Alake'.
3. J. Spottiswoode, *Otta Intelligence Report* (Abeokuta, 1935).

the rise of a town the size of Abeokuta. The manner in which this town was founded gave it all the importance of a premier home for all Egba. The result has been that until recently all projects for development and nearly all educational facilities in the Division were concentrated in this one town. This gave rise to a considerable drift of population, particularly the youthful section, from the rural areas to Abeokuta. The clamour for a more equitable distribution of modern amenities has led to a re-organization of the Division into one urban and thirteen district council areas. The new district councils have also been given powers to raise local rates for development work in their area. They are thus likely to become more and more conscious of their primary responsibility to develop the economic capacity of their districts as against any sense of obligation they might feel towards Abeokuta. This new trend will undoubtedly reduce the drift of population from the rural areas to the town.

The second consequence resulting from this type of settlement evolution is that of the multiplicity of scattered holdings. Most farmers have farm holdings in at least two of the regions. This means a periodical movement between the two holdings. Thus, a farmer who has inherited a holding in region (A) and has acquired another in (B) tends to devote the former to food crops and the latter to cocoa and kola, and he oscillates between the two farms as their needs demand. This periodical movement represents a substantial loss of working hours. Farmers with such dual holdings often neglect the poorer one, allowing their relatives to cultivate it on condition that the proceeds from the sale of palm produce is returned to them.

A third consequence is that this pattern of settlement evolution has facilitated the process of individualization of farm holdings. Amongst the Yoruba, the family, not the clan, is the unit owner of land—a fact which considerably circumscribes the right of alienation of any single member of the family. A family, however, represents the second, third or fourth generation of owners. The first generation of owners would conceivably own their lands as individual and, therefore, alienable freehold. The events of the early nineteenth century in Egba Division meant, in effect, a return to this primary situation of first owners. Most of the adult males who migrated to Abeokuta (real or potential heads of families) were in their time individual owners of the land they appropriated, and could freely exercise their rights of alienation.

Two new factors in particular gave ample opportunity for the exercise of this right and helped to further, but not to create, the advanced stage of land individualization noticed among the Egba at the beginning of this century.[1] The first was the arrival of Sierra Leone immigrants (kinsmen who were freed slaves) from 1838 onwards. Many of these came to speculate extensively in land. The second factor was the rise of an export trade, first in palm oil and kernels and later in cocoa. Thus, from about 1860 onwards, according to Price, sales of land had become a common phenomenon in the Division—a situation unparalleled in any other part of the country until recently.[2] It is important to stress the relationship in this Division between the nature of settlement evolution and the resulting situation in land tenure, in order to make clear that other factors, besides the mere introduction of new tree crops, were responsible for the growth of the idea of individual ownership and of the right to alienate. This provides a qualification to Lord Hailey's statement that an advanced stage in the individualization of holdings is reached in tropical Africa only under the impact of the introduction of

1. *Report of the West Africa Lands Committee, 1912* (Colonial Office, 1916), pp. 452-4.
2. H.L. Ward Price, *Land Tenure in the Yoruba Provinces* (Lagos, 1939).

new economic crops.[1] For, by contrast, there is the greater part of Yorubaland where the introduction of economic crops has not necessarily led to much individualization of holdings. In fact, in most of these areas, sales of land are still rare.

The fourth and final consequence of this pattern of settlement is the phenomenon of a large number of rural market points to serve the needs of the highly dispersed agricultural population. Most of the markets are not residential places but are attended every fourth or eighth day by large numbers of traders and farmers. Some, like Obafemi, have become settled in recent years. Moreover, improved transportation is leading to uneven development amongst these markets. Those which are well served by transport facilities are being settled and becoming bigger and more important, whilst remote ones are being deserted.

Conclusion

In concluding, reference may be made to the issue raised in the report of the 1931 Census, quoted above, that high density of rural settlements means greater efficiency in agricultural exploitation. There can be no final statement on this matter, particularly in the absence of any comparative study of conditions in other areas with low density of rural settlements, and in view of other factors, such as the time-consuming periodical movement of farmers and differences in environmental conditions. In 1948 Buchanan and Pugh calculated that Egba Division had the highest output of agricultural export production (£750) per square mile in Western Nigeria and this seemed therefore to confirm the observations of the 1931 Census.[2] The highest densities of settlement, however, are found in the poorer, food-producing areas of Egba Division, particularly around Abeokuta. The strong tendency also noticed in these areas towards the desertion of settlements emphasises that, whatever the initial greater proficiency that comes from proximity to the land farmed, the failure to improve on the traditional bush fallow system of cultivation leads to the gradual disappearance of the economic advantage of high densities of rural settlements.

1. Lord Hailey, Introduction to C.K. Meek, *Land, Law and Custom in the Colonies* (London, 1949).
2. K.M. Buchanan and J.C. Pugh, *Land and People in Nigeria* (London, 1955), p. 128.

BOOK REVIEW

MALAYA. By Norton Ginsburg and Chester F. Roberts, Jr.

Singapore: Donald Moore, 1958. 5¼ x 8¼ inches.
xiv and 533 pages; 28 maps; 4 figures; 71 tables;
bibliography and index. Malayan $13.50

An interdisciplinary team has produced a valuable handbook on Malaya. It will be useful to many, but it is difficult to say to whom it will appeal most. One of the present notions about book-writing is that a team of workers can do a better job than can a lone scholar. The notion holds that if many persons from many disciplines scan many sources, assemble much data on many topics, and put much effort into compilation while consulting many experts, there will result a work that takes the place of many works. There certainly is merit in the thought, but unless everyone concerned is careful indeed, the result may become a strange compendium of data and 'interpretation' grouped into units given chapter titles but containing little true integration and slight intellectual stimulant. At its best the product of team writing easily exceeds the product of a good single scholar; at its lower level the output of a team can be an unexciting and curious phenomenon. The volume MALAYA, under the guidance of Norton Ginsburg, geographer, and Chester Roberts, working in international affairs, falls about midway of the varied quality levels achieved by current team products. A project stemming originally from the Human Relations Area Files, sponsored by the American Ethnological Society, compiled at the University of Chicago, but published elsewhere, this volume clearly shows its multiple parenthood. Though the senior author is a geographer, the volume is not a geography; but neither is it ethnology nor sociology, neither international affairs nor economics. It is neither Malaya nor Malayans that stand out of this work, but the book is about different kinds of people in Malaya, and about their distributions, ways, habits, customs, occupations, politics, language patterns, doings and non-doings. The concern of the book is to measure most of the stuffs of human culture in Malaya to the maximum amount that can be got between the covers of a 533 page volume. The result is both astounding and, in a cumulative sort of way, overwhelming. It almost has to be useful to almost anyone wanting to know almost anything about Malaya.

Conceived, compiled, and written in the United States without special field investigation, the volume suffers from the distance at which it was done, both in terms of psychological awareness, and in terms of the source materials. An effort was made to compensate for this by the use of such Malayan experts as could be brought to Chicago during the compilation. The primary aim of the volume is to provide a sort of bench-mark against which to judge the Malaya that became independent on 31st. August 1957. To do this the compilers deliberately sought to cover a wide range of subject matter and, in particular, to assess the varying position of the separate ethnic communities that inhabit Malaya. This is a worthy objective, and thirty years from now it may well be looked back upon as such a bench-mark. To many of us today, however, the basic data planes vary almost too greatly for the volume to be one bench-mark. The population datum essentially is that of 1947, that of the telecommunications system is 1954, and that of political action is early 1957. Particularly does the population datum seem out of context for a contemporary bench-mark in a small country whose population total changes appreciably in a short span of years.

The book opens with a chapter on the Malayan Peninsula; most volumes on a region have such a chapter, so here we find one. It possibly was written after the rest of the volume was compiled, for the short section on soils, for example, is quite unrelated to the discussion of agriculture in a later chapter, but the brief summary will orient many readers to some aspects of the nature of the place. Chapter two on Past and Present briefly sets the historical house in order, leaving the detailed aspects of the British organization of government in Malaya for a later chapter. Chapter three extracts the lean meat, the key tables, and the chief illustrative maps, in redrawn form, from the 1947 Census—the latest available when the project began and ended. This, and later chapters, dealing with population account for 5,848,910 people. An estimate by the reviewer based on the preliminary summary from the June, 1957 Census, suggests a total of 7,617,000 on 31st. August 1957, the bench-mark date of concern to the compilers. This total is an appreciably larger total than that dealt with in chapter three. Chapter four provides a nice discussion of settlement patterns, but a somewhat incomplete coverage, and Chapter five describes the formal machinery of communication and transport.

In Chapter six one finds the heart of the volume, in many respects, a sixty page consideration of Human Communication in a Plural Society. Do Chinese, Malays, Indians, Europeans, and others communicate with one another as persons or as groups? Is Malaya one 'country' or several? Are people learning to think in terms common to all, or is the ethnic unit perpetuating itself by developing a special mode of mass human communication peculiar to it alone? These are vital questions for Malaya. Though I would not hold that the whole of this chapter is geography, it forms one of the main stuffs of regional human geography, and all students of regions inhabited by several ethnic groups of different mores would do well to study it carefully. Chapters seven, eight and nine are long chapters devoted to the primary ethnic groups, Malays, Chinese, and Indians. Each chapter attempts to describe and analyze the social, economic, and political culture pattern of a particular sector of Malayan society. It is here that interdisciplinary research has spread itself most widely in the range of materials.

Chapter ten considers the Economic System of Malaya; though the outline includes all the topics, the end product is less than the whole of the parts. Despite ample commentary elsewhere in the volume on the rise of cash cropping and commercial facets of economy among the Malays, this chapter leads off with the old generalization that the Malay segment of the economy is non-commercial; the concern with rice and rubber reduces the consideration of coconuts to a short paragraph, again despite the commentary elsewhere on the significance of the coconuts to Malay life. Is this perhaps because the first draft of this chapter was written by an historian?

In chapter eleven, on Political Organization and Development, lies much of the interest of at least some of the compilers. This is the longest chapter in the volume, and it follows in considerable detail the evolution of the bewildering multiplicity of political administrative forms and structures that have made Malaya such a puzzle to much of the world. The chapter brings the discussion of political events forward to the actions, in the spring of 1957, that preceded the independence of the Federation of Malaya. It is here that the roles and techniques of Malays, Chinese, and Indians in the going political life of Malaya show up clearly. A short final recapitulation succeeds fairly well in looking beyond the mass of detail to sum up the chief points about several peoples living somewhat separately in one region, and those points about the multiplicity of economic and political structures that have resulted therefrom.

Working at a distance, without ample recent field notes, it is inevitable that numerous small errors occur, but they do not seriously lessen the value of the work. Wandering through the corridors of Nanyang University, as a visitor in early May, 1958, I heard only an occasional English word spoken by lecturers, and English is not the language of instruction, as mentioned on page 162. At the bench-mark date of 31st. August 1957, there were not anywhere near 6,500 terrorists left active, and probably not even the lower figure of 3,500 mentioned on page 272. No Malayan would look for a pedicab in which to ride, page 261; a tri-shaw is the local term, but in any case their number is dwindling steadily in favour of bicycles and taxis. Some of the statistics cited, from dates 1947 to 1954, as indicative of the *status quo* at the bench-mark of 31st. August 1957, are no longer truly indicative, so rapidly is the situation changing. Persons thoroughly at home in the Malayan scene will recognize other aberrant details of fact.

Despite this reviewer's reaction to the effectiveness of team writing, and despite the age of some of the data used to represent the present, the volume is a first order achievement for Malaya. It does form a bench-mark of sorts, it is a mine of information, it does combine in one volume materials scattered widely in the literature on Malaya, and its use will save many hours for persons interested in a wide range of data. Thanks should go to all persons and agencies responsible for its production.

J. E. Spencer.

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